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INDEX TO VOLUME XIV.

OCTOBER, 1897, TO MARCH, 1898.

The titles first appearing under each classification-head are those of leading articles in the Magazine. The titles in smaller type, which follow, indicate articles from other journals which have been editorially noticed in the "Review of the Engineering Press."

ARCHITECTURE AND BUILDING.

PAGE.

THE ESTHETIC TREATMENT OF ENGINEERING WORK. *H. H. Statham.* 103

THE AMERICAN TALL BUILDING FROM A EUROPEAN POINT OF VIEW. . . . . . *S. H. Capper.* 239
With 12 Illustrations.

THE TALL BUILDING FROM AN AMERICAN POINT OF VIEW. . . . . *A. D. F. Hamlin.* 436

EUROPEAN SYSTEMS OF HOUSE HEATING. . *J. L. Saunders.* 635

THE HOT-WATER SYSTEM FOR THE HEATING OF BUILDINGS. . . . . . . *J. J. Blackmore.* 817
With 10 Illustrations

THE CONSTRUCTION OF SLOW-BURNING BUILDINGS. *Francis C. Moore.* 955
With 3 Illustrations.

REVIEWS.

Bridge Design, Esthetics of................ 494
Building Laws, New York 1032
Cantilever Foundations.................... 670
Cast-Iron Columns, Tests of...... 1031
Cottage Hospitals... 137
Distortion, Architectural.................. 666
Esthetics of Bridge Design. 494
Exposition of 1900......................... 323
Fire on Structural Steel, Action of.......... 312
Foundations, Cantilever.................... 670
Foundations in Compressed Earth.......... 318
Healthful Buildings............ 864
House-Heating, Humidity in.............1029
Maltese Architecture...................... 862
New House of the German Engineers...... 145
New York Public Library, Competition for.. 134
Pompeian Restorations.................... 872
Preservation of Iron in Buildings........... 311
Strength of Bins 304
Structural Steel, Action of Fire on......... 312
Study of Architecture, Proper.......... ... 675
Style in Architecture, National............. 494
Theatre Construction, Iron.................1049
Ventilation, Natural....................... 143

INDEX to leading articles on Architecture in the Architectural and Engineering Press, including Construction and Design, Heating and Ventilation, Landscape Gardening, Plumbing and Gas-Fitting, and Miscellany.............................155, 327, 519, 691, 879, 1053.

CIVIL ENGINEERING.

PAGE.

MODERN WHARF IMPROVEMENTS AND HARBOR FACILITIES . . . . *Foster Crowell.*
I. Private Enterprise and Political Blight in Typical Atlantic Cities. . . . 12
With 19 Illustrations.
II. The Expansion of Docks, Wharf Sheds, and Means of Transportation. . . 205
With 24 Illustrations.

III. The Dependence of Shipping Upon Graving and Repair Docks. . . 444
With 17 Illustrations.

The Esthetic Treatment of Engineering Work. *H. H. Statham.* 103

The Growing Importance of Cement in Constructive Work. . . . . . *E. W. Dewey.* 267

The Protection of Shores Against Encroachments of the Sea. . . . . *E. L. Corthell.* 402
With 4 Illustrations.

The Control and Fixation of Shifting Sands. *John Gifford.* 603
With 9 Illustrations.

The Relations of Forestation to Water-Supply. *H. M. Wilson.* 807

Peculiar Features of Irrigation Engineering in Colorado. . . . . . . *H. A. Crafts.* 829
With 8 Illustrations.

The Adjudication of Water Rights in Irrigated Regions. . . . . . . *Elwood Mead.* 1000
With 2 Illustrations.

The Electric Development of Hydraulic Power. *F. C. Finkle.* 1011
With 18 Illustrations.

REVIEWS.

Altitude Measurements, Photographic...... 686
Berne, New Bridge at.................. 322
Bouzey Dam Disaster..................... 319
Breakwater Construction.................1027
Bridge, Alexander III, Caissons of......... 515
Bridge at Berne, New................... 322
Bridge, New Faidherbe.................. 684
Bridge Replacement, Important............ 500
Bridges, Recent German.................. 513
Caissons of the Alexander III Bridge....... 515
Canal, Dortmund........................1046
Colombo Harbor Works................... 507
Dam Disaster, Bouzey.................... 319
Deep Waterways to the Atlantic........... 667
Dortmund Canal........................1046
Dredging, Hydraulic..................... 669
Eckmühl Lighthouse 514
Excavating Devices...................... 304
Faidherbe Bridge, The New.............. 684
France, River Gagings in................. 870
Harbor Works at Colombo................ 507
Hemet Dam............................ 497
Hydraulic Dredging..................... 669
Hydraulic Mortar.......................1044
Inland Navigation...................... 868
Inland Waterways in Germany............. 145
Liernur Sewage System at Trouville........ 149
Lighthouse, The Eckmühl................. 514
Loire, Improvements at the Mouth of....... 509
Material of Construction, Slag as a 876
Measurements, Photographic Altitude 686
Melan Arch in America.................. 307
Mouth of the Loire, Improvements at....... 509
Müngsten Viaduct. 871
Navigation, Inland..................... 868
New Docks at Buenos Ayres.............. 137
Piers, Coffer-Dam Process for............. 134
River Gagings in France................. 870
Simplon Tunnel 323
Ship Canal, Proposed Russian............. 317
Slag as a Material of Construction......... 876
Society of Civil Engineers, American....... 665
Viaduct, Müngsten...................... 871
Waterways to the Atlantic, Deep.......... 667
Wind Pressure, Measurement of........... 679

Index to leading articles on Civil Engineering in the Engineering Press, including Bridges, Canals, Rivers and Harbors, Hydraulics, Irrigation and Miscellany.............................. 157, 330, 521, 693, 881, 1056.

ECONOMICS AND INDUSTRY.

PAGE.

The Industrial Awakening of the Russian Empire. . . . . *F. J. Guyon.* 64

The Effects of Trade-Unionism Upon Skilled Mechanics. . . . . . *Hiram S. Maxim.* 189

FUTURE SUPREMACY IN THE IRON MARKETS OF THE WORLD. . . . . *J. Stephen Jeans.*
I. The United States vs. Europe as a Manufacturing Competitor. . . 196
II. A Comparison of Conditions in Various Countries. 393
III. Competition in Point of Crude Materials. 583
IV. Conditions Affecting the Manufacture of Finished Products. 842
NATIONAL DIFFERENCES IN LABOR-HANDLING METHODS. . . . . . . *Hiram S. Maxim.* 365
THE FAILURE OF LEGISLATION TO ENFORCE RAILWAY COMPETITION. . . . . . . *H. T. Newcomb.* 473
AUTOMATIC MACHINERY THE SECRET OF CHEAP PRODUCTION. . . . . *Hiram S. Maxim.* 593
OBJECTIONS TO MUNICIPAL OWNERSHIP OF ELECTRIC PLANTS. . . . . *T. Carpenter Smith.* 780
THE ADJUDICATION OF WATER RIGHTS IN IRRIGATED REGIONS. . . . . *Elwood Mead.* 1000
With 2 Illustrations.

REVIEWS.

Accounts, Diagram........................ 676
Business Methods in Russia................1050
Cost of Power............................. 687
Diagram Accounts 676
Education of Engineers.................... 859
England, Foreign Machinery in 861
Engineering Industry, The Struggle in 314
Engineering Progress in 1897, Review of...1042
Engineers, Education of................... 859
Engineers' Strike......................... 673
Exposition at Stockholm 510
Foreign Competition and Technical Education 504
Labor-Saving Machinery................... 501
Machinery in England, Foreign............ 861
Machinery, Labor-Saving 501
Old Paper 511
Paper, Old............................... 511
Power, Cost of 687
Russia, Business Methods in..............1050
Stockholm, Exposition at................. 510
Technical Education and Foreign Competition 504
Trade Teaching, Theory and Practice in.... 144
INDEX to leading articles on Economics and Industry and Industrial Sociology in the Engineering Press, and Current Reviews, including Commerce and Trade, Currency and Finance, Governmental Control, Labor, and Miscellany.........................159, 332, 524, 696, 883, 1059

ELECTRICAL ENGINEERING.

PAGE.
ELECTRIC POWER FOR TRUNK-LINE RAILWAYS. . *George Forbes.* 1
THE ENORMOUS POSSIBILITIES OF RAPID ELECTRIC TRAVEL. . . . . . *Charles H. Davis.* *F. Stuart Williamson.*
I. Sufficiency of Present Appliances and Engineering Methods. . . 32
With 28 Illustrations.
II. Analysis of a Heavy Investment and the Probably Ample Returns. . 253
STANDARDS OF PRACTICE IN ELECTRIC-ELEVATOR INSTALLATION. . . . . . . *P. R. Moses.* 479
With 7 Illustrations.
THE POSSIBILITIES AND LIMITATIONS OF ELECTRIC TRACTION. . . . . *F. J. Sprague.*
I. Individualized Car Equipment the Starting-Point of a New Progress. 553

II. The Multiple-Unit System Applied to Trunk-Railway Operation . 752
THE ELECTRIC DEVELOPMENT OF HYDRAULIC POWER. . . . . *F. C. Finkle.* 1011
With 18 Illustrations.

REVIEWS.

Arc, Utilization of the Power of........... 869
Bakersfield Transmission................. 303
Bleaching by Electricity 324
Boats, Electric Traction of................ 151
Dangers Connected with the Supply of Electricity............................ 138
Dynamos, New Method of Constructing.... 133
Electrical Engineering, Precision of........ 306
Electro-Chemistry, Development of........1037
Electro-Chemistry in Germany.... 146
Eletcro-Chemical Progress............... 675
Energy, Equalization of Electric....... ... 499
Equalization of Electrical Energy......... 499
Heat, Electricity as a Source of............ 497
Hydro-Electric Power Plant, The Largest... 136
Incandescent Lamps, Renewal of.........1048
London Underground, Electricity on the... 506
Machinery, Electrical Driving of...........1040
Plows, Electric......................... 152
Precision of Electrical Engineering......... 306
Progress, Electro-Chemical............... 675
Transmission, Bakersfield......... 303
Transmission in Workshops, Electrical...... 682
X-Rays, Physiological Action of........ . 324

INDEX to leading articles on Electrical Engineering in the Engineering Press, including Electro-Chemistry and Metallurgy, Lighting, Power, Telegraphy and Telephony, and Miscellany..161, 335, 527, 698, 885, 1062.

MARINE ENGINEERING.

PAGE.
ERICSSON'S FIRST MONITOR AND THE LATER TURRET SHIPS. . . . . . *George L. Fowler.* 110
With 15 Illustrations.
STATUS OF THE WATER-TUBE BOILER IN THE AMERICAN MARINE. . . . . *W. M. McFarland.* 411
With 19 Illustrations.
SHIP-BUILDING AS A PRODUCTIVE INDUSTRY IN GREAT BRITAIN. . . . . . *James McKechnie.*
I. The Economic Relations of its Enormous Growth. 372
With 13 Illustrations.
II. The Reciprocal Influence of Private Enterprise and Naval Dominion. 561
With 20 Illustrations.
III. Decline of Sail and Evolution of Steamship Types. . . . 763
With 14 Illustrations.
IV. Ratio of Output to Wages the Deciding Factor in Competition. . 936
With 15 Illustrations.

REVIEWS.

Engineer in the Navy...... 1028
Future of Marine Engineering............. 129
Gunboat Trials, U. S.................... 670
Oceanic, Building of..................... 312
Powerful, Speed Trials of the.... 502
Screw Propellers, The Performance of...... 855
Speed Trials of the Powerful........... ... 502
Steamers, Water-Ballasting of............1036
Trials, U. S. Gunboat........ 670
Water-Ballasting of Steamers....... 1036
Water-Tube Boilers in High-Speed Ocean Steamers...................... 139

INDEX to leading articles on Marine Engineering in the Engineering Press and Current Reviews, including Boilers and Engines, Naval Affairs, and Miscellany..... ....166, 340, 530, 705, 890, 1067.

MECHANICAL ENGINEERING.

PAGE.

COST-KEEPING METHODS IN MACHINE SHOP AND FOUNDRY. . . . . . . *Henry Roland.*
  I. The Elements of Cost and the Influence of Wage Systems. . . 56
  II. Details of Practice in Widely-Known Shops. 225
  III. Control of the Store-Room and Checking of Piece Production. . 464
  With 1 Illustration.
  IV. Problems of General Expense and Fixing of Selling Prices. . . 626
DISTRICT DISTRIBUTION OF ENERGY. . . *C. E. Emery.* 94
THE ECONOMICAL GOVERNING OF STEAM ENGINES. . . . . . . *J. S. Raworth.* 262
With 1 Illustration.
STATUS OF THE WATER-TUBE BOILER IN THE AMERICAN MARINE . . . . *W. M. McFarland.* 411
With 19 Illustrations.
STANDARDS OF PRACTICE IN ELECTRIC-ELEVATOR INSTALLATIONS. . . . . . *P. R. Moses.* 479
With 7 Illustrations.
AUTOMATIC MACHINERY THE SECRET OF CHEAP PRODUCTION. . . . . . . *Hiram S. Maxim.* 593
THE ECONOMY AND EFFICIENCY OF THE LARGE GAS ENGINE. . . . . . . *Dugald Clerk.*
  I. Early Efforts, and the Development of Modern Types. 615
  With 9 Illustrations.
  II. Leading Problems now Awaiting Solution. 758
  With 1 Illustration.
EUROPEAN SYSTEMS OF HOUSE HEATING. . *J. L. Saunders.* 635
THE TRANSMISSION OF POWER BY BELTS AND PULLEYS. . . . . . . *C. L. Redfield.* 641
With 3 Illustrations.
EQUIPMENT AND ORGANIZATION OF A CITY FIRE DEPARTMENT. . . . . . *Hugh Bonner.* 789
With 17 Illustrations.
THE HOT-WATER SYSTEM FOR THE HEATING OF BUILDINGS. . . . . . . *J. J. Blackmore.* 817
With 10 Illustrations.
THE ECONOMICAL UTILIZATION OF EXHAUST STEAM. *Bryan Donkin.* 930
THE DEVELOPMENT OF MACHINERY FOR METAL STAMPING. . . . . . *Oberlin Smith.* 973
With 51 Illustrations.
THE ELECTRIC DEVELOPMENT OF HYDRAULIC POWER. *F. C. Finkle.* 1011
With 18 Illustrations.

REVIEWS.

Air-Compressor Explosions.............. 148
Animated Pictures...................... 860
Armor-Piercing Projectiles 311
Armor-Plate Board...................... 858
Bicycles, Military...................... 320
Centrifugal Pumps, Theory of............ 867
Cleaning Metal, Sand Blast for........... 500
Coals, Calorific Value of................ 666
Compressed-Air Explosions...............1030
Current Motors.........................1045
Cylinder Heads, Strength of............. 683
Diesel Motor........................... 147
Efficiency, Steam-Boiler 496
Entropy Diagram....................... 319
Feed-Water, Purification of.............. 672
Gas Engine and its Mission...............1033
Gas Plant, A Power..................... 866
Great Falls Power Plant.................. 306
Hydraulic Motors.......................1038
Hydraulic Power, Development of......... 321
Machinery, Electric Driving of............1040
Mathematics for Engineers............... 671
Military Bicycles....................... 320
Niagara Power Plant, Extension of........ 305
Powdered Fuel......................... 303
Power Plant, Great Falls................. 306
Power Plant, Metropolitan Street Ry. Co.... 858
Power Plant, Niagara, Extension of........ 305
Projectiles, Armor-Piercing............... 311
Pumping-Engine Test.................... 313
Recording Apparatus, Mechanical......... 516
Rope Driving 668
Safety Appliances, Confidence in 301
Sand Blast for Cleaning Metal 500
Steam Boiler Efficiency.................. 496
Steam Cylinders, Compression in 681
Stokers, Automatic 853
Superheated Steam.....................1043
Testing Materials, A New Method of 682
Test, Pumping-Engine................... 313
Tools, English and American............. 865
Value of Coals, Calorific 666
Water-Power Plants, Limits of Regulation for.............................. 130
Water Power, Questionable Economy of.... 149
Water-Tube Boilers in High-Speed Ocean Steamers 138
Wire-Drawn Steam...................... 503
Wire Rope, Strength of.................. 873

INDEX to leading articles on Mechanical Engineering in the Engineering Press, including Boilers, Furnaces and Firing, Compressed Air, Engines and Motors, Power and Transmission, Shop and Foundry, and Miscellany..167, 341, 532, 707, 891, 1068.

MINING AND METALLURGY.

PAGE.

EXPLORING AND EXPLOITING A GOLD COUNTRY. *Albert Williams, Jr.* 70

IRON-ORE LOADING ON THE AMERICAN GREAT LAKES. *H. J. Slifer.* 275
With 17 Illustrations.

THE CYANID PROCESS FOR GOLD ORES IN WESTERN AMERICA. . . . . . . *Thomas Tonge.* 652
With 17 Illustrations.

THE GOLD MINES OF THE WITWATERSRAND, SOUTH AFRICA. . . . . . . *John Hays Hammond.*
I. Their Rapid Development, and the Geology of the Region. . . . 733
With 14 Illustrations.
II. Their Approximate Value, Probable Life, and the Local Mining Laws. . 911
With 13 Illustrations.

MINING LAW IN BRITISH COLUMBIA, MEXICO, AND THE UNITED STATES. . . . . *R. W. Raymond.* 925

METHODS FOR THE RECOVERY OF BY-PRODUCTS OF THE BLAST FURNACE. . . . . *A. Humboldt Sexton.* 987
With 10 Illustrations.

REVIEWS.

Blast-Furnace Gases, Utilization of 1039
British Coal Industry.................... 315
British Coal Supply.....................1035
Bulkheads for Mines, Portable............. 514
Chinese Mining Communities 510
Coal Industry, British 315
Coal Supply, The British.............. ...1035
Communities, Chinese, Mining............ 510
Copper Tools, Antique................... 875
Explosions in Mines 150

Explosives in Gaseous Mines 1047
Gaseous Mines, Explosives in.............1047
Gold Placers and Lodes 495
Iron, Protection of from Rust 1040
Iron and Steel, Mixtures of.. 685
Lodes and Gold Placers............... 495
Metallography as a Method of Research.... 685
Roasting Previous to Cyaniding 131
Spontaneous Ignition of Coal............ 135
Steel, Mixtures of Iron and.............. 685
Stone Cutting with Wire Saws 1040
Submarine Coal-Mining in Spain.......... 141
Tests of Metals, Portable Recorder for 140
Utilization of Blast-Furnace Gases 1039
Ventilation of Mines..................... 514
Western Mill Construction, Defective...... 130

INDEX to leading articles on Mining and Metallurgy in the Engineering Press, including Coal and Coke, Copper, Gold and Silver, Iron and Steel, Mining, and Miscellany....................171, 346, 537, 713, 897, 1074.

MUNICIPAL ENGINEERING.

PAGE.

OBJECTIONS TO MUNICIPAL OWNERSHIP OF ELECTRIC PLANTS. . . . . . . *T. Carpenter Smith.* 780

EQUIPMENT AND ORGANIZATION OF A CITY FIRE DEPARTMENT. . . . . . *Hugh Bonner.* 789
With 17 Illustrations.

THE CONSTRUCTION OF SLOW-BURNING BUILDINGS. *Francis C. Moore.* 955
With 3 Illustrations.

REVIEWS.

Acetylene Mixtures..................... 674
Asphalt Pavements...................... 308
Corrosion from Mains of Water-Works, Removal of Internal 141
Electricity and Gas...................... 503
Fire-Protection in London.... 680
Garbage Disposal........................ 493
Gas Mantles, Incandescent 863
Gas, Purification of...................... 142
Gas and Electricity 503
Healthful Buildings 864
Incandescent Lamps, Renewal of..........1048
Leeds, Sanitary Congress at............... 309
Liernur Sewage System at Trouville........ 149
London, Fire-Protection in....... 680
Paris Sewer Construction................. 512
Pavements, Asphalt 308
Refuse Destructors.... 309
Sanitary Congress at Leeds............... 309
Sewage Purification at Spandau 686
Sewer Construction, Paris................ 512
Sewer Pipes, Strength of.................1034
Spandau, Sewage Purification at........... 686

INDEX to leading articles on Municipal Engineering in the Engineering Press, including Gas Supply, Sewerage, Streets and Pavements, Water-Supply, and Miscellany......................176, 351, 541, 718, 901, 1078.

RAILWAY AFFAIRS.

PAGE.

ELECTRIC POWER FOR TRUNK-LINE RAILWAYS. *George Forbes.* 1

THE ENORMOUS POSSIBILITIES OF RAPID ELECTRIC TRAVEL. . . . . . . *Charles H. Davis.*
I. Sufficiency of Present Appliances and Engineering Methods. . . . *F. Stuart Williamson.* 32
With 28 Illustrations.
II. Analysis of a Heavy Investment and the Probably Ample Returns. . . 253

PROGRESS IN THE PERFECTION OF THE RACK RAILWAY . . . . *E. L. Corthell.* 76
With 11 Illustrations.

IRON-ORE LOADING ON THE AMERICAN GREAT LAKES. . . . . *H. J. Slifer.* 275
With 17 Illustrations.

ENGLISH GOODS STATIONS AND RAILWAY YARDS. . *Arch. R. Whitehead.* 289
With 9 Illustrations.

THE FAILURE OF LEGISLATION TO ENFORCE RAILWAY COMPETITION. . . . . . . *H. T. Newcomb.* 473

THE POSSIBILITIES AND LIMITATIONS OF ELECTRIC TRACTION . . . . *F. J. Sprague.*
I. Individualized Car-Equipment the Starting Point of a New Progress. . . 553
II. The Multiple-Unit System Applied to Trunk-Railway Operation. . . 752
BRITISH RAILWAY FARES, AND THEIR INFLUENCE ON TRAFFIC. . . . . *W. J. Stevens.* 964

REVIEWS.

Ballast, Oil-coated 132
Bridge Replacement, Important 500
Caillet Monorail 683
Coupler Law, Federal 498
Electric Traction on Elevated Roads 302
Elevated Roads, Electric Traction on 302
Freight Cars, English and American 861
High-speed Locomotives 677
Historical Locomotives 495
Law, Federal Coupler 498
Locomotive Building, American 856
Locomotives, Geared 857
Locomotives, High-speed 677
Locomotives, Historical 495
Locomotives, Oil-Fired 311
Monorail, Caillet 683
Oil-Fired Locomotives 311
Paris, New Railway Station at 874
Railway Station at Paris, New 874
Simplon Tunnel 323
South Africa, Railroad Building in 505

INDEX to leading articles on Railway Affairs in the Engineering Press, including New Construction, Maintenance of Way, Terminals and Yards, Transportation, and Miscellany ....187, 355, 545 721, 904, 1081.

STREET AND ELECTRIC TRAMWAYS.

PAGE.
THE ENORMOUS POSSIBILITIES OF RAPID ELECTRIC TRAVEL. . . . . *Charles H. Davis.*
I. Sufficiency of Present Appliances and Engineering Methods. . . . *F. Stuart Williamson.* 32
With 28 Illustrations.
II. Analysis of a Heavy Investment and the Probably Ample Returns. . . 253
THE POSSIBILITIES AND LIMITATIONS OF ELECTRIC TRACTION. . . . . . . *F. J. Sprague.*
I. Individualized Car-Equipment the Starting Point of a New Progress. . . 553
II. The Multiple-Unit System Applied to Trunk-Railway Operations. . . 752

REVIEWS.

Dover Tramway 316
Electric Traction 678
Electric Tramways in Germany 1050
Electric Tramways in New York 854
London Underground, Electricity on the.... 506
Power Plant, Metropolitan Street Ry. Co.... 858
Tramways in Germany, Electric 1050
Tramways in New York, Electric 854
Traveling Platform at Paris Exposition 317

INDEX to leading articles on Street and Electric Tramways in the Engineering Press, 181, 359, 549, 725, 908, 1085.

BOOKS RECEIVED AND REVIEWED.

Notices under these heads appear on Pages ....185, 362, 727.

THE

ENGINEERING MAGAZINE

VOL. XIV. OCTOBER, 1897. No. 1.

THE APPLICATION OF ELECTRIC POWER ON TRUNK-LINE RAILWAYS.

By George Forbes.

IN accepting the invitation of the editor of THE ENGINEERING MAGAZINE to write an article upon electric traction with special reference to its probable extension to trunk lines, it is not the writer's purpose to instruct engineers in the duties of their profession, or to suggest to manufacturers any new directions in which to work, but simply to give those who are financially interested in railways the results of disinterested and careful study and extensive calculation. After casting a retrospective glance over what has been accomplished, he will endeavor to indicate the directions in which electric traction is advancing, and to state in broad and general terms the conclusions that he has arrived at as to the cost of works and facility of carrying them out.

In dealing with this subject, it must be borne in mind that circumstances differ. The street railway has developed to a marvellous extent in America, whereas in some European countries it has not found general favor. The cause of this lies largely in the differing circumstances. Countries are also affected in varying degrees by the amount of their suburban traffic, while the introduction of electric traction must also depend on the amount of underground communication in large towns. And other special features arise, such as the facility of obtaining water power for generating electricity or the difficulty of getting water for the generation of steam.

The first town to be thoroughly equipped with electric street railways was Richmond, Virginia (in 1878, on the Sprague system), and from that date their development has been by leaps and bounds.

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Moreover, it has been continuously in the same direction, and, while competitive systems have at various times come forward and may prevail at some future time, yet the overhead trolley system has so far almost monopolized the field. The consequence is that the general methods of working have remained tolerably uniform, although there have been decided improvements in the details of machinery. In the United States, where this development has been most rapid, the systematizing of methods has become as complete as in the case of steam railways, and this applies to construction as well as equipment. The figures showing the present state of development are startling to those who have not yet realized them. It is impossible at present to get details of what has been done up to the present moment; the following figures are for 1895, up to which date sufficiently correct estimates have been prepared. At the end of 1895 in the United States there were 12,583 miles of electric street railways in operation. The capital invested in electric street railways at the same time was $1,400,000,000 ; the net gross receipts, $164,250,000 ; expenses, $113,500,000 ; number of passengers carried, 3,000,000,000. These figures alone are sufficient to impress anyone accustomed to deal with the development of large industries.

A good many years ago the writer was in attendance at a meeting of electrical engineers in New York, and, after numerous statements had been made about the progress of electric street railways in the United States, he was invited to give information as to what was being done in England. He then confessed that progress in electric tramways on the other side of the Atlantic had been very slow, but he described the principal development of electric traction which had taken place, and characterized it as being on new lines, saying that possibly this single instance might turn out to be almost equal in value to the street-railway work which had already been described. He referred to the City and South London Railway, which cannot be looked upon as a tramway in any sense of the word, but is a solid railroad properly constructed, its great distinction from the electric tramways being in the fact that the trains were hauled by electric locomotives. Several of his brother engineers in America grasped this fact at once, and were quite prepared to admit that, in the development of the electric locomotive, of which this was the first step, there might be a future worthy of comparison with what had been done in the propulsion of individual cars on street tramways. No assertion was made that the adoption of the locomotive was opening a new era ; the statement was simply that the London experiment was one of great interest to all electrical engineers who wish to have a hand in moulding the future of this department of engineering. Since that date electric locomotives have been used on many railways. The facts are not generally known to the public, and it is not out of place here to refer to special cases.

The Niagara Falls Park and River Railway. This railway is 12 miles long, of double track, resembling in every way the standard adopted by the Canadian Pacific Railway. The maximum speed attained is 30 miles an hour. Trolley wires are used. There are two motor houses: one at the falls, worked by water power; the other a small auxiliary station at the Queenstown end of the road, with steam plant. There is 15 minutes' headway between cars, the average speed, including stoppages, being 13 miles an hour. Locomotives, in the ordinary sense of the term, are not used, but twenty-two motor cars supply this service, and are followed by trailers, etc. Some of the cars, when fully loaded with passengers, weigh more than twenty tons. There are eight regular stopping-places along the line, furnished with platforms.

This railway has been referred to, not because of any special merit which it possesses, but because it is not a street railway, and because it shows a method of working. In fact, reference is made to it partly to draw attention to the extremely objectionable feature of it. When water power was available, it was not good policy to use steam power at a distance of 12 miles. Of course, if the electric pressure were only 500 or 600 volts, there would be a great waste of energy or an enormous expenditure of copper in carrying the current to even that short distance; but there would have been no difficulty in transmitting electrical power at high pressure, transforming it down, and converting it into a continuous current. This would have saved nearly the whole expense of working the steam plant. It is important to give attention to this matter of the use of water power on trunk railways. There has been an absurd hesitation to undertake the transmission of power to great distances. If engineers who have had experience in the transmission of power and in the conversion of alternating into continuous currents would look into this question, they would be convinced that where water power is available it is generally economical to transmit electrical power hundreds of miles for working railways. As an example, it can be proved that, if the railway companies of Scotland were to combine to work their trunk lines by means of electric locomotives, the electric current being developed by the water power which exists in that country, then the whole of that service might be carried on without the use of steam locomotives.

Another lesson to be drawn from a careful consideration of the subject is that the waste of coal on steam locomotives is not by any means compensated by the extra cost and loss of power in electrical transmission. Estimates have been prepared which show that not only is the cost of copper prohibitive, but that the efficiency of the electric system renders the consumption of coal with stationary engines about as great as with locomotives. This is certainly not the case. The cost of electric transmission, when properly effected, is not comparable with what it is as calculated on the lines adopted in the past; and, on the other hand, the efficiency of dynamos and motors has not been sufficiently considered in street-railway practice in the United States. A very large part of the success of the Liverpool Overhead Railway is due to the high efficiency of the electrical machinery.

The Baltimore Tunnel. This is a section of the Baltimore & Ohio Railway which it was found desirable to work electrically. The tunnel runs under Baltimore city, and is 7,339 feet long, 27 feet wide, and 22 feet high. There is a steady grade of 0.8 per cent. from south to north. The passenger trains are pulled through the tunnel, and the freight trains are pushed the entire distance, steam locomotives in the latter case assisting them in the open. The calculations were for a maximum weight of 500 tons per passenger train, including locomotive, with a speed of 35 miles an hour; for freight trains, a weight of 1,200 tons and a speed of 15 miles an hour. The locomotives have four gearless motors, two to each truck. All the freight and passenger trains are run through the tunnel by electric locomotives. The following are examples of what has been done on this line. A train weighing 1,125 tons was hauled up a gradient of 42 feet to a mile by the electric locomotive. At the end of one minute the train was moving at 10½ miles an hour. In another case, with a total weight of 1,068 tons, the electric locomotive gave a drawbar pull of 25,000 pounds, as measured by a dynamometer; with a speed of 11⅛ miles per hour and a train of 1,600 tons the drawbar pull was 45,000 pounds. On another occasion a train weighing 1,900 tons was started in the tunnel, and the maximum drawbar pull was 60,000 pounds at 12 miles per hour. This case is cited as showing that electric locomotives are capable of doing all that can be done by steam locomotives. The first locomotive supplied has been running steadily since August 4, 1895.

Nantasket Beach Electric Railway. This electric railway is a branch of the New York, New Haven & Hartford Railway. It is 7 miles long, with some sharp curves, and there is a gradient of 34 feet to the mile. There are stops about every quarter of a mile. Motor cars are used with trailers, with a drawbar pull amounting in some cases to 8,000 pounds. Further extensions of this railway in the same direction have been made, with the use of a third rail between the ordinary rails as a conductor for electricity. These extensions are from New Britain to Berlin and from Hartford to New Britain. There are twenty-two grade-crossings, at each of which the third rail is replaced by underground cables. This electric railway is cited here as the first instance of the supplanting of steam by electricity on a standard American railway.

Liverpool Overhead Railway. The length of this line is 6¾ miles, of standard gage. A third-rail conductor is laid between the ordinary rails. There are two motors on each train, one at each end, each motor being of 40 h. p. This line was designed with the utmost care. The machinery was not taken from stock patterns, but specially designed to give high efficiency, the benefits from which have been thoroughly appreciated. This line deserves consideration as comparable with the one next to be considered, and as illustrating the advantage of applying motive power to the wheels of the train instead of to a locomotive, wherever possible. It can be shown that the greatest advantages are attained when the electric power is applied to every axle of the train, and this is the direction in which engineers ten or fifteen years ago expected that electric traction on railways might be developed. The inconveniences and expense, however, of replacing the whole of the old rolling stock by new, and the unsuitability of the system generally to existing lines as worked by steam, have rendered the use of a locomotive of the utmost importance in all applications to railroads where steam has been used.

The City and South London Electric Railway. This railroad has 3¼ miles of double line. It is driven by electric locomotives, each of which has two motors, giving in all 100 h. p. A third rail is used for the electric conductor. This was the first electric railway introduced in London, and its operation has been studied by engineers and railroad men with great interest. A few figures are given below for the two electric railways last mentioned. Some comparisons with the Metropolitan District Railway are also introduced, excluding the goods trains, as the other railways are only for passengers. The figures are as follows :

City and South London Electric Railway.

Miles travelled by passenger trains		451,609
Cost of locomotive and generating plant	£11,407	
Repairs and renewals of carriages	£ 874	
		£12,281

or $\frac{12281}{451609}$ = £.027, or 6.48d. per train-mile.

Liverpool Overhead Railway.

Miles travelled by passenger trains		632,763
Cost of locomotive power (including stationary engines)	£ 9,448	
Repairs and renewals of carriages	£ 456	
		£9,904

or $\frac{9905}{632763}$ = £.016, or 3.84d. per train-mile.

Metropolitan District Railway.

Miles travelled by passenger trains		1,369,999
Cost of locomotive power (including stationary engines)	£54,556	
Repairs and renewals of carriages	£12,793*	
		£67,349

or $\frac{67349}{1369999}$ = £.049, or 11.76d. per train mile.

In connection with these figures it should be noted: (1) that the District Railway trains are approximately four times the weight of those of the other two (electric) lines, the weights, according to Messrs. Greathead & Fox's paper, published in the Minutes of the Institute of Civil Engineers, Vol. 117, p. 67, being as follows:

City & South London Railway.			Liverpool Overhead Railway.			Met. District Railway.		
T.	Cwt.	Qrs.	T.	Cwt.	Qrs.	T.	Cwt.	Qrs.
37	7	0	38	5	2	157	10	0

(2) that, if the train mileage for the two electric railways was increased to that of the Metropolitan District Railway, the figures for cost of locomotive power would doubtless be reduced.

The remarkable economy of operating the Liverpool Overhead Railway has surprised all those whose experience in electrical traction has been limited to street railways. The reasons for this excellent performance lie partly no doubt in the cheapness of fuel and of labor, but far more in the good quality of the track and the care taken in designing and supplying efficient machinery.

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* The Metropolitan District Railway has, out of 400 vehicles, 41 carriages and wagons other than those used for conveyance of passengers. Therefore the figures given in the published returns for repairs and renewals are too high by, say, one-tenth. The figure given above under this heading has been obtained by reducing that given in the returns by this amount.

The examples chosen must not be looked upon as an exhaustive list of cases where electric traction has been successful in competition with steam. They are typical cases, each illustrating some point which it is desirable for the public interested to have knowledge of. There has been no example of a long trunk line worked electrically, but, from the examples already given, it can be taken as thoroughly established that this is not due in any way to want of capability in the electric locomotive. The reason why trunk lines have not been worked by electricity is that, rightly or wrongly, those who have had the matter to decide have considered the cost of transmitting electric power too great. There would be nothing experimental in carrying out such a work, and the estimates of cost can be made out with the greatest accuracy. In an article like the present, intended for business men, as well as technical experts, such estimates should not be introduced; but it is necessary to draw attention to the fact that, in a great deal that has been written on the subject, it has been assumed that the electric pressure upon the feeders is only some 600 or 700 volts. Without assuming to advance any new idea upon the subject, the writer may cite as indisputable the fact that the feeders may be supplied with current at 10,000 volts or more, which may be in the form of continuous current, but which is more manageable as an alternating current. At different stations along the line it would be reduced in pressure by means of transformers, and converted into continuous current by means of a commutating machine. It is in this point that machinery for working the proposed system has been the least developed. The commutating machine now on the market, introduced first by Mr. Shuckert in Germany, and applied in various factories at the Niagara works, is usually called a rotary transformer. It does its work admirably, but it is expensive, cumbrous, and requires continual attention. This last fact renders it impossible to lay such machines along a trunk line at distances of a few miles. But I have prepared the designs for a transforming and commutating machine free from all the defects referred to, which can be manufactured at small cost. For years I have impressed upon manufacturers the desirability of such a machine, and it is only a matter of time when they will find that it is to their own interest to provide it. Viewed in the light of the adoption of very high electric pressures, the cost of transmitting the power electrically is not at all the serious matter that it has been considered, but, in spite of this fact, human inertia may prevent rapid progress in the direction of working trunk lines electrically. After wide experience and a laborious study of the whole question, the opinion of the present writer is that, as a rule, electric locomotives, with the power developed by steam, would, if the work were carried out on proper lines, be cheaper than the steam railroad up to a distance of between 40 and 50 miles from the power station. If water power were available for generating the electricity, the distance at which steam power would begin to be the cheaper on a busy line is several hundred miles. These statements are the result of calculations with coal at a dollar and a half per ton. This economy arises from the well-known fact that in the best trial tests of locomotives five pounds of coal are required for the h.-p. hour, and from the fact, equally well known, that so good a result is rarely attained, in nearly every case the consumption of coal being several times as much as that indicated. These conclusions, however, do not give much encouragement for the substitution of electricity for steam, except in special cases. A time may come when special railroads will be built over long distances to be worked electrically, and in that case there are advantages of a totally different character which will favor electricity, depending upon the fact that the locomotive will be abolished and power applied to every axle of the train.

In the year 1881, the present writer, in the course of some correspondence from the Paris Electrical Exhibition to the London *Times*, drew attention to the possibilities of electric traction on railways. That article was really the summary of a lecture which had been delivered before Anderson's College, in Glasgow, in 1879. In that article he drew attention to the remark made by Captain (now Sir) Douglas Galton, in the concluding paragraph of his report on experiments conducted by himself and Mr. Westinghouse on the air-brake when used with trains going at high speed. In that report Sir Douglas Galton said: "The advantage which thus evidently ensues from utilizing the adhesion of every wheel of a train suggests the further consideration as to whether it would not be a more scientific arrangement, as well as more economical in regard to the permanent way of railways, to utilize the adhesion of every wheel of a train for causing a train to move forward, instead of depending for the moving force upon the adhesion of one heavy vehicle alone,—namely, the locomotive." The present writer then pointed out that this fertile suggestion might be carried out by the employment of electric motors on the wheels or axles of each carriage. He further pointed out that such a system would result in a saving wear and tear of the permanent way, a diminution of shocks and injuries to passengers and goods, and a facility in going around curves. Besides this, the wheels would not slip when going up steep inclines, and, in starting from a station, speed could be attained in a small fraction of the time now required. As a secondary advantage, the construction of the permanent way would be very much less costly. This is undoubtedly the way in which an electric railway should be worked. It was supported by able engineers, and many of us can remember the admirable writings of Mr. Sprague upon the subject, in which he made it abundantly clear that such a system of traction would be beneficial in every way.

Although the method of working just described is ideal, it can be applied only to a trunk line about to be constructed in total independence of existing steam railroads. If anything is to be done on a large scale with trunk railroads, it must be by means of locomotives, and the advantages of an electrical system using locomotives are not nearly so great as in those cases in which electricity is applied to every axle of the train. It is owing to the great importance of these considerations that so much money has been spent on, and attention devoted to, the Heillmann locomotive, in which steam is generated on the train for the purpose of creating an electric current to be supplied to motors driving all the wheels of the train. Without saying that this complicated system has proved a success, still there is no doubt that those who have invested capital in the experiment have been satisfied that there is enough advantage in this method of propulsion to justify the carrying-on of extensive experiments. The whole of the advantage lies in the fact that power is delivered to every wheel of the train, no advantage being gained from the cheaper use of fuel at a stationary engine.

The examples given, while they indisputably show that electric traction under certain conditions is well able to compete with steam, are not sufficient to overcome the natural conservatism which holds to existing methods.

Hitherto reference has been made chiefly to the great trunk lines, but special attention must be given to the conditions of suburban traffic. Most of us remember, not so very many years ago, the surprise with which we learned that several short steam railways were having to give way to the electric tramways which had been started. In later years it is the great steam railway companies which have been noticing with alarm that their receipts are being largely diminished by the competition with electric tramways for suburban traffic. That this competition is so successful is due to several causes. One is that the natural roads and streets have been employed for the purpose, so that little or no purchase of land has been necessary. But perhaps the most important cause is the rapid succession of independent cars which becomes possible under this system, affording a great convenience to the traveling public and enabling them in many cases to start from their places of business in town and be landed at the doors of their houses in the suburbs. These are very serious matters from the point of view of the railroad companies, because many of the companies are really dependent for their profits upon suburban traffic, and, if this source of revenue is to be taken away, it will seriously endanger the financial position of the railroads as a whole. These matters have become more evident in the United States than in any other country.

At the first glance it seems almost impossible for a railroad with fixed railway stations to be able to compete in convenience with an electric tramway passing along the ordinary thoroughfares, picking up and letting down passengers at all parts of the journey. Most persons, however, who know the conditions of traffic in the neighborhood of large towns in the United States, will probably agree that this matter of convenience does not apply to every householder, and that householders' wants, so far as this point is concerned, would be fully met if the stopping-places on the trunk line were in direct communication with the local street railways of the place.

A great deal has been written upon the comparative cost of working the suburban traffic upon trunk lines by steam and electricity. The question of a slight difference in cost one way or the other is of far less importance in the matter than the question whether it is possible for the suburban lines to run independent trains at a shorter headway,—a system practically impossible with steam locomotives, but advantageously workable from a central electric power station. If the public felt certain of being able to find a car or train ready to take them along the well-laid trunk railroads to their destination, so that they would never have to wait more than a few minutes at the station, there is no doubt that a great preference would be shown for travelling along these well-equipped lines. This appears to be the only solution that affords the railroad companies a hope of escape from the competition which they now have to face.

It must not be forgotten that there are some cases where electric traction is perfectly certain to take the place of steam, but, as a rule, these are special cases. Such supersedure will never be possible with trunk lines, except where water power is easily available. For a railway through a desert there cannot be the slightest doubt that electric locomotives would facilitate, not only the construction, but the working of the lines. During a recent visit to, and inspection of, the military railways on the Upper Nile the present writer was impressed with the enormous difficulties of carrying the railway from Wady-Halfa across the desert, where no water could be obtained for a distance of 230 miles, to Abu Ahmed. The difficulty consisted in the fact that, after the first one hundred and fifty miles had been laid, for every train carrying rails and sleepers there had to be three or four trains carrying coal and water to supply the locomotives. He took occasion to impress this fact upon the authorities, and to show that, if the construction were to be entirely carried out as proposed, from the Wady-Halfa end of the line, it would be almost essential to work by means of electric locomotives. While these pages are being written, the sirdar has succeeded in capturing Abu Hamed, and doubtless the most important result of this success is that it enables him immediately, during the flood-season, to carry rails and sleepers to Abu Hamed, and to carry on the construction of the line from both ends, so diminishing the difficulty which threatened.

Another case in which electricity is bound to supplant steam is that of underground railroads, especially in London; and the great increase in the number of electric railroads in London is the surest evidence that before long the whole of the underground system will change from steam to electricity. This change would have been accomplished long ago, were it not for the expense of the transition stage, and certain difficulties which attached to the necessary change from steam to electricity on trains coming from the country into the underground system of London. These difficulties have been much exaggerated, and there is really nothing to prevent the immediate introduction of electricity in the underground system of London.

The conclusions derived from study extending over many years are as follows:

(1) In cases where water power is always available within a few hundred miles of a trunk line of railway, it is probable that economy would be served by introducing electric traction.

(2) In the case of an independent system of railway to be constructed in a new country utterly unaffected by the traffic from steam railroads, power can be applied to every axle of the train; wherefore it will be economical in such a case, in construction and in operation, to use electric propulsion in preference to steam.

(3) For desert railways, where water cannot be obtained, electric traction is eminently suitable.

(4) In underground railways, such as the Baltimore Tunnel and the London underground system, where economy is not so important as convenience and comfort, electricity must be employed; and, where such railways are to be constructed, economy makes electricity advisable.

(5) In cases of suburban traffic electricity would help to overcome the competition with street railways by supplying the public with separate and independent cars running at very frequent intervals on a well-maintained track.

MODERN WHARF IMPROVEMENTS AND PORT FACILITIES.

By Foster Crowell.

I. PRIVATE ENTERPRISE AND POLITICAL BLIGHT IN TYPICAL ATLANTIC CITIES.

THE steamship New York of the American line on her fifty-sixth voyage reached her New York berth, at Pier 14, North river, at 8.35 A. M., November 17, and sailed again at 10 A. M. November 18. The total time in port was twenty-five hours and twenty-five minutes, and there were only twenty-one and one-half working hours. But in that brief period there were discharged and loaded 3,467 tons of miscellaneous cargo, at the rate of 165 tons per hour, and about 2,400 tons of coal were put on board, at the rate of 112 tons per hour. In addition to this, 904 sacks of mail and the luggage of 613 passengers were handled,—that is, about 450 tons of mail and baggage. In round numbers the total stands as follows:

Cargo,	3,467	tons.
Coal,	2,400	"
Mail, etc.,	450	"
Total,	6,317	"

an average of 300 tons per working hour. This performance was undoubtedly a record-breaker in the field of handling miscellaneous cargo, and the officials of the International Navigation Company, from the highest to the lowest, still love to dwell on the "New York's quick turn," but there is no reason whatever to doubt that it could be repeated, or even excelled, at any time at Pier 14, although it is questionable whether there is at the present time any wharf equipment elsewhere capable of approaching it. While this was going on, the Red Star steamship "Friesland," of the same company, was loading on the other side of the same pier, and there were about 1,000 tons of her cargo on the wharf, besides 1,550 tons of "east-bound" for the New York. The capacity of the pier is far greater than that, however; at one time fully 8,000 tons of cargo were upon it, and the superintendent estimates that he "could put 12,000 tons measurement of cargo on Pier 14 and leave a driveway for trucks to come in and go out."

To go back to the handling operation, let us see first what this 6,317 tons really means, and what appliances and how many men are

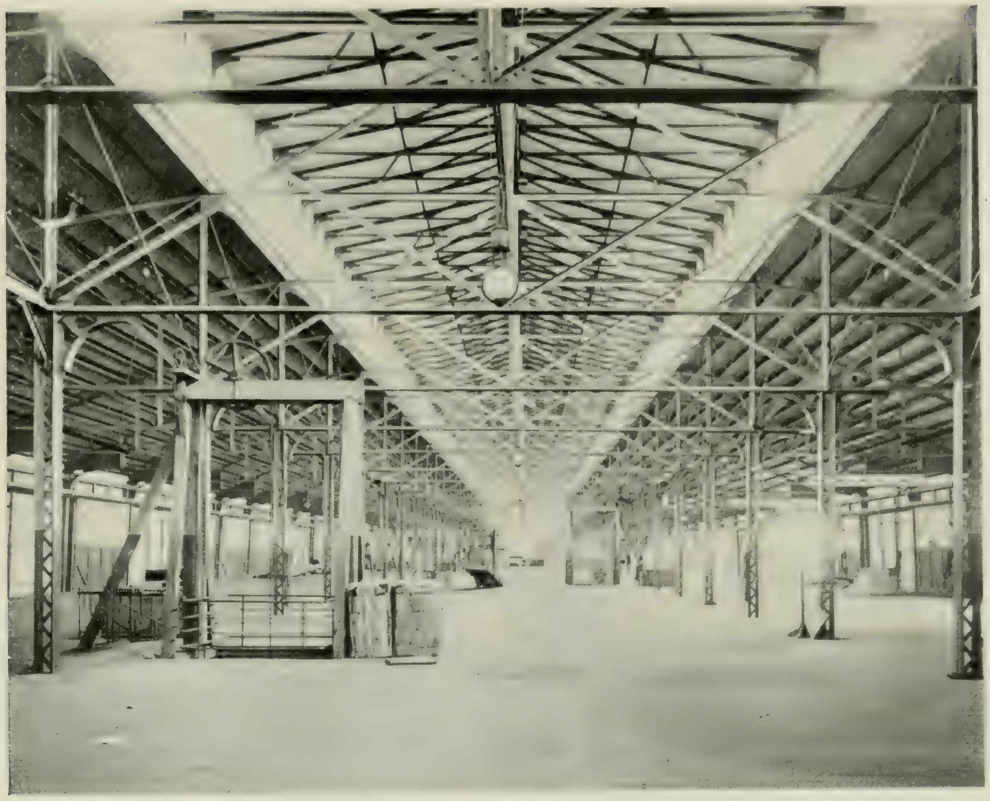
THE NEW YORK PIERS OF THE AMERICAN LINE.
From a photograph furnished by Mr. Edward F. Wright, Dock Superintendent.

required. We will leave out of consideration the details of organization; for it may be taken for granted that they are of a very high order indeed, as the accomplishment in fact demonstrates. To bring to the wharf 6,317 tons of freight would require about 420 freight-cars (of the average size in use on American railways, or about twice that number of goods-wagons of the ordinary European type), if it could be brought in that way, which is not at present possible; if it came by trucks and drays, as some of it does, though by no means all, nearly 5,000 would be required. Before further discussing this subject of the handling of cargoes at the wharf, a digression may be pardoned, to condemn the habit of miscalling a wharf a "dock." New York rather plumes herself on being cosmopolitan, and is fond of characterizing neighboring cities as "provincial"; but at bottom she is as much so as any of them, and never more so than when she sets foot "on a dock" or appoints a "dock board" to build piers and bulkheads and wharves and everything, almost, along-shore, excepting docks, of which, to her shame be it said, and certainly to her disadvantage, she so far does not possess a single one, not counting the Atlantic and the Erie basins, which are private enterprises in Brooklyn, a city heretofore untrammeled by public ownership of the water-front.

In the case before us the number of men employed in handling this vast tonnage was: on cargo, 206; on coal, 135. This means that the movement amounted to nearly one ton per hour per man, taken from the hold and placed on the pier, or loaded and stowed, as the case might be. The ship's winches did most of the work on cargo; the fixed wharf winches are used only for landing part of the cargo. The coaling is all done by the wharf winches and a floating hoister.

The ship has seven hatches for cargo, and at each are several booms working to the same winch, with separate falls so arranged that the cargo can be brought to the deck by one lift and placed on wharf or in hold by another; or they can work in the same way to or from lighters on the outside of the ship. The wharf winches on Pier 14 are placed on the lower, or main, floor; but on Pier 15 they are on the second floor, these being the only two-storied piers in New York used for ocean passenger business. The second story is the best place for them, as it gives the operator a complete view of his work under all circumstances. On Pier 14 there are four Williamson double winches, each with two separate barrels, so that eight distinct operations can be going on simultaneously without interference; the lifts lead either to stepped derricks resting on the projecting main floor, outside the wharf-house, or "shed" in the vernacular, and hinged so that they can be folded back to clear the ship's side when not in use, or else to pulley-blocks running horizontally on a heavy wire rope which extends parallel to the wharf, just outside the shed, being rove through permanent and fixed vertical pole-derricks. The latter arrangement permits of the pulley-blocks being placed between the fixed derricks anywhere along the ship's side, the supporting wire rope (2½ inches in diameter) being capable of sustaining a load of five tons in any one bay.

The floating hoister consists of a covered scow, on which are winches with four barrels, working in connection with stepped derricks rigged temporarily on the ship; or the winches may be used to operate derricks on lighters. In coaling ship the shore winches and four stepped-derricks on the wharf side, and the floating hoister and four stepped-derricks on the ship, can be operated simultaneously, with a united effect of 140 tons of coal per hour, the coal being brought in barges, which lie, of course, along both sides of the ship. Much out-bound cargo does not come upon the wharf at all, but is hoisted on board directly from lighters by means of the floating hoister, by the ship's winches, in some cases, by their own power. Thus the full effective handling capacity can be exerted. Space does not permit a description of many interesting features of an ocean



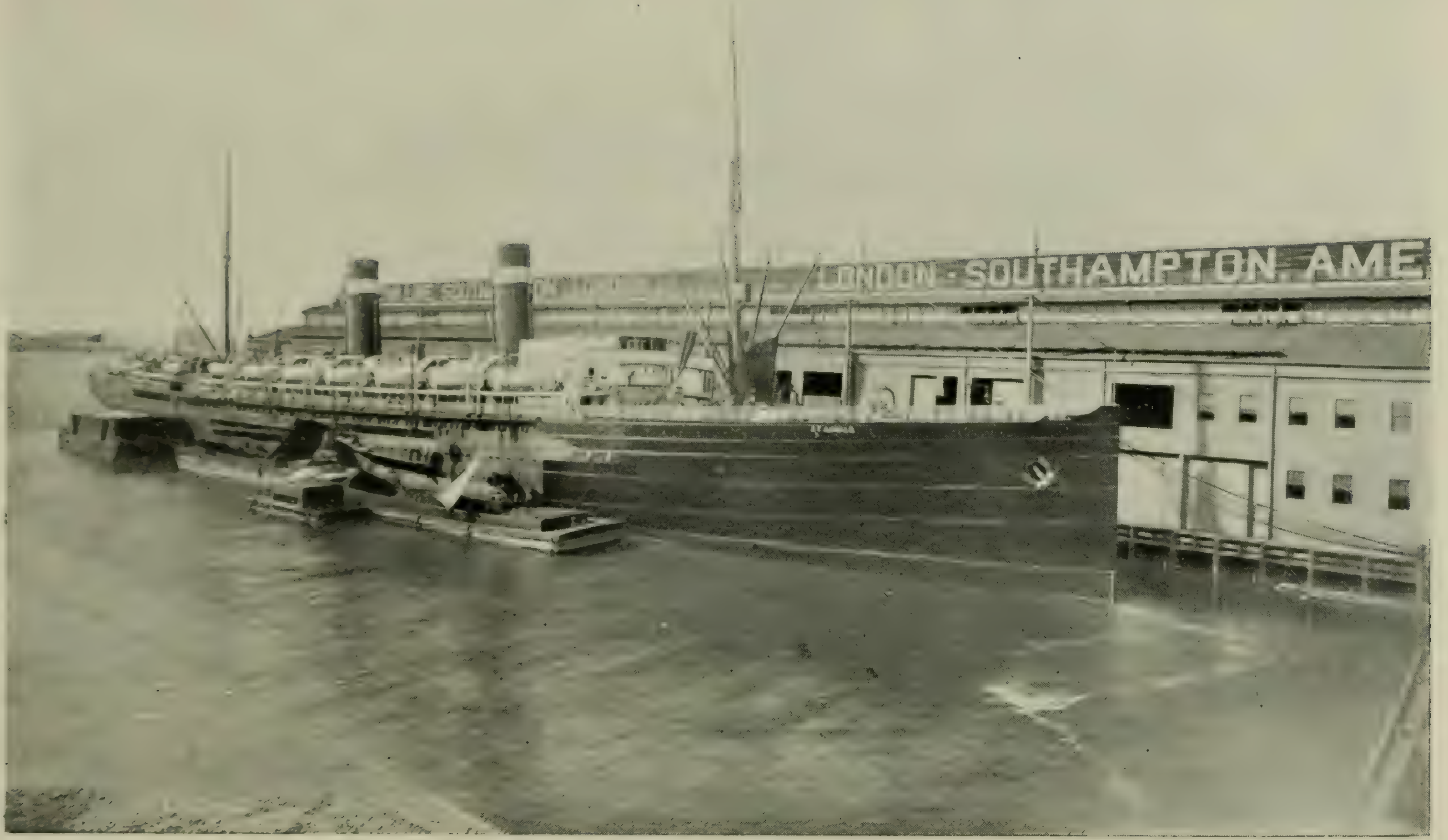
SECOND STORY OF AMERICAN LINE PIER, NEW YORK.

liner's cargo stowage and the special provisions and accommodations made therefor; for instance, on board the American liners there are large refrigerator holds for meats destined for the English markets; these meats are killed and dressed in the abattoir in New York harbor, and brought to the ship in refrigerator barges, from which they are loaded directly into the hold.

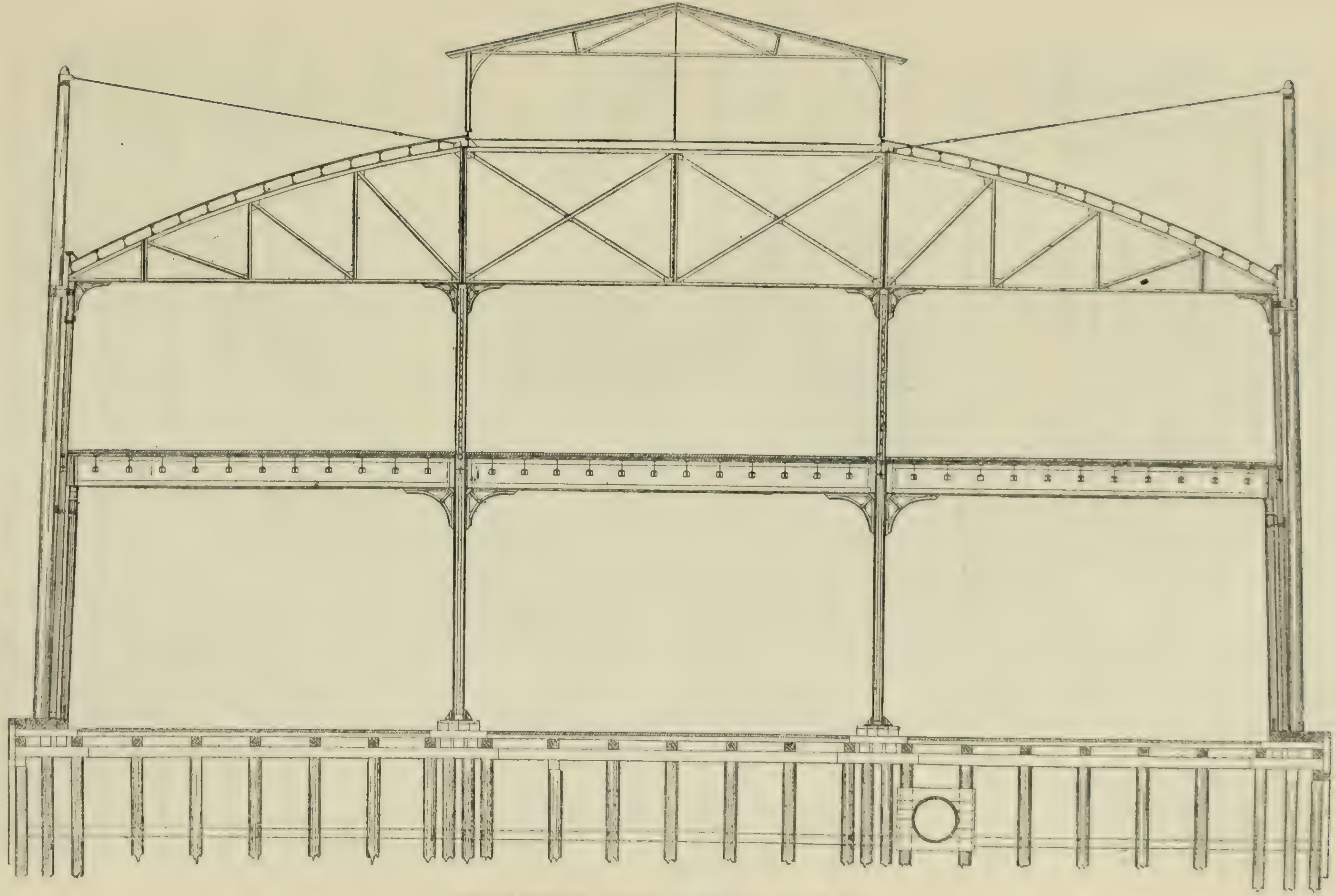
The floating hoister has its self-contained power, but the wharf winches are permanently piped for a supply of steam direct from the battery of boilers at the head of the wharf, which also provide the power for electric lighting, for fire-protection pressure service, etc. A description of the plant, very perfect of its kind, is not essential to the purpose of this article.

The facilities for embarking and disembarking passengers at the American line piers are far in advance of the ordinary practice, both by reason of the upper floor, which is used for that purpose, and which extends over the entire pier, and by the generous and intelligent provisions (utterly unknown elsewhere) for the minor comforts of passengers and their friends who come to welcome or to speed.

The comfort and facility of the second-floor arrangement strike one favorably in going "to see friends off," or in waiting for the ship to come up after she has been reported: but its chief value is en-



STEAMSHIP ST. LOUIS OF THE AMERICAN LINE COALING AT PIER 14, NEW YORK.



CROSS SECTION OF THE AMERICAN LINE PIER.

From the Company's Plans, through the courtesy of Mr. Clement Acton Griscom, Jr., Manager International Navigation Co.

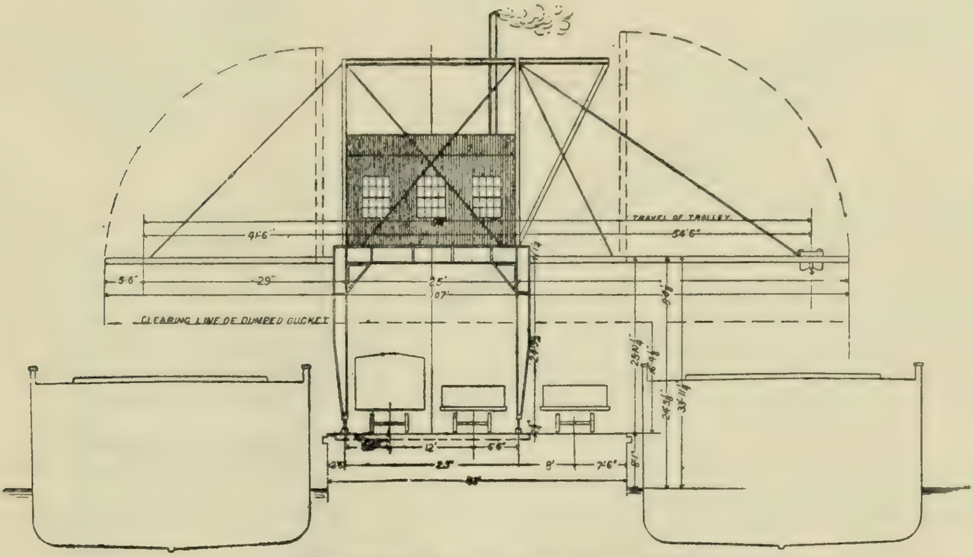
joyed by the incoming passenger, for the horrors of the customs inspection are materially mitigated by it, and one can get through that barbarous business with much less annoyance and loss of time, owing to ample space unobstructed by anything else at the time, and to the system adopted of segregating the passengers according to the letters of their names and arranging the baggage for inspection correspondingly in separate spaces plainly marked with large letter signs. The second-class baggage is also kept separate, so that the least possible time is consumed, and at the worst the passengers are in physical comfort, relieved of confusion and trouble. When each one's luggage is "passed," it can be sent down a chute to the lower floor, at the head of the wharf, where carriage or express-wagon can drive in to get it. I have selected the wharf just described, because it is a specimen of the most advanced type; it is by no means typical, as has been stated, of the general condition on either side of the ocean, and it can truthfully be said that, compared with it, most of the present wharf outfits in use are primitive in the extreme. While it is gratifying to Americans to note that the most advanced and best plant is that of the only transatlantic American line, it can scarcely be satisfactory to national pride to reflect that in provision for commerce generally, throughout the seaports, the United States are behind the rest of the world.

This condition is undeniable, and is due doubtless to the fact that the United States have no merchant marine of their own, speaking of course relatively. To state why they have no merchant marine would be a repetition of the story of "the house that Jack built."

> This is the platform, tattered and torn,
> Made by a party all forsworn,
> That milked the national cow too long,
> That tossed the tariff,
> That worried trade,
> That caught the panic,
> That ate the profit,
> That lay in business before that.

But this is not intended to convey the idea that there are not, in the United States, appliances suitable for wharf developments on the very highest scale; as a matter of fact, there are; it is only the opportunity for applying them to foreign commerce that is lacking. In the lake ports, and in private enterprises at many other points, there are in service plants as far in advance of the rest of the world as the ocean port facilities of the United States are behind it; and in the shipment of grain, of course, the great American elevators, though now somewhat antiquated, have for many years been famous.

This article deals with present conditions, which were well epitomized recently by a prominent railroad official in charge of the New York piers and the marine business of one of America's several "greatest railroads," when he remarked that in the last thirty years there has been no change in wharf methods and appliances; he was speaking, of course, of New York particularly. He was at the time, however, exerting himself to have new methods and plant devised and adopted which would revolutionize the business of freight-handling and vastly reduce the cost, and, since then, the changes he proposed have in part been decided on, and the illustration on this page shows one of the plants about to be erected.

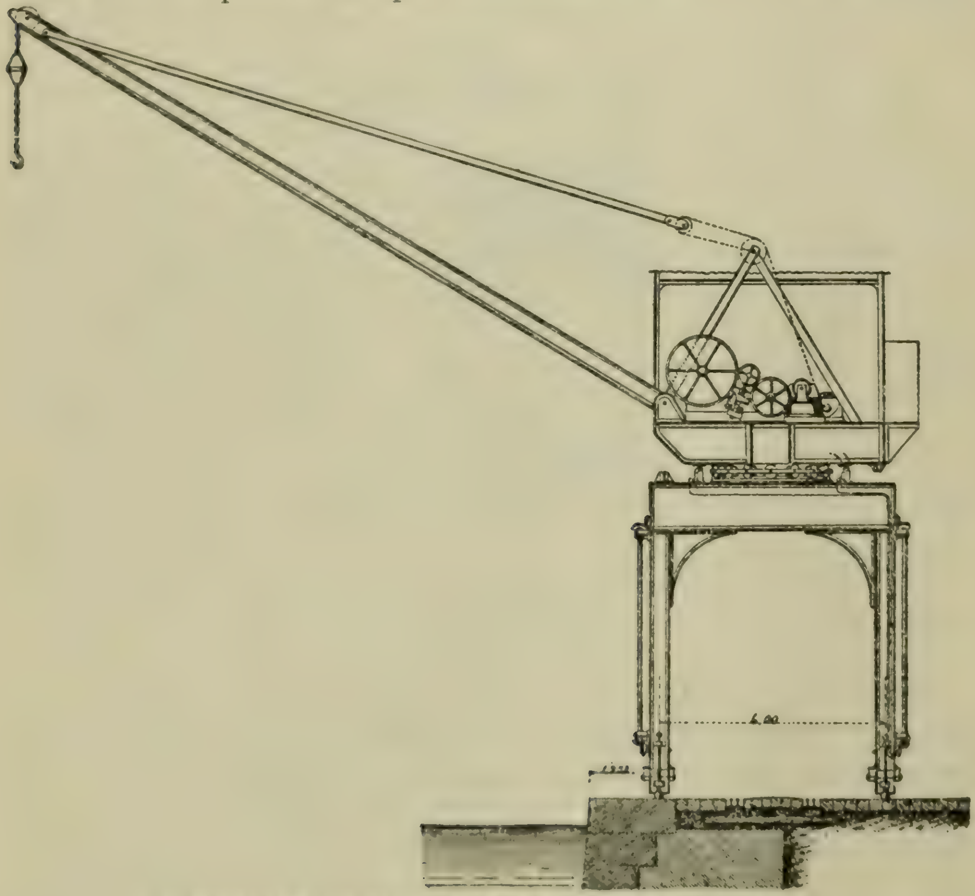


LOCOMOTIVE STEAM WHARF MACHINE.

Designed and built by the Brown Hoisting and Conveying Machine Co. for the Pennsylvania R. R., Pier J, Jersey City.

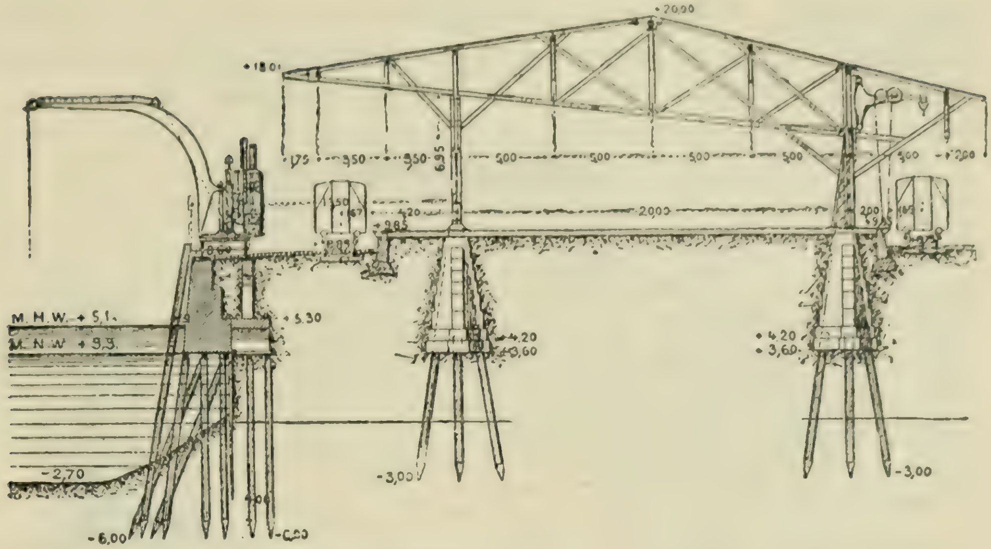
This machine is of 5 tons' lifting capacity, and is equipped with automatic buckets for handling bulk material; these buckets can be detached and the hook used for handling boxes, bales, or any other articles. By an arrangement of hoppers in connection with the pier leg at the left of the machine, bulk material can be loaded into box cars; this is an important part of the specifications for the machine, as on this pier a great deal of pyrites, sulphur, etc., is transferred from ships into box cars. To the right of the machine there is one track outside the pier leg. This arrangement was made so that long material, such as steel rails, lumber, etc., can be loaded and unloaded without having to pass any obstruction. The entire machine is driven by a steam engine and boiler in the house on top, and, besides hoisting its full load 150 feet per minute, will travel with full load along the pier at a speed of 600 feet per minute. The projections over the vessels are hinged, so that they can be thrown into a vertical position when not in use, leaving the edge of the wharf clear. These projections, or aprons, are raised by power. This machine is the first of its type, and it is expected to revolutionize the handling of material in New York harbor. It has been designed and manufactured, though not yet erected, by the Brown Hoisting and Conveying Machine Company, of Cleveland.

Other signs of a new era in wharf-plant development in the United States are not wanting, and the new wharves now being, or about to be, built at the port of New York will probably show a distinct advance from the present antiquated standard.



ELECTRIC CRANE PROPOSED FOR THE PORT OF DUNKIRK.

It may be said generally that what is true of New York in this regard applies in the main to the other American seaports; here and there, already, there are notable departures from the old usages and methods. For example, compressed-air locomotives and electricity have been tried on New Orleans wharves to expedite the shipping of cotton, and other sporadic cases of improvement might be mentioned; nevertheless, the fact remains, baldly stated, that old and costly methods of handling miscellaneous cargoes from wharf to ship

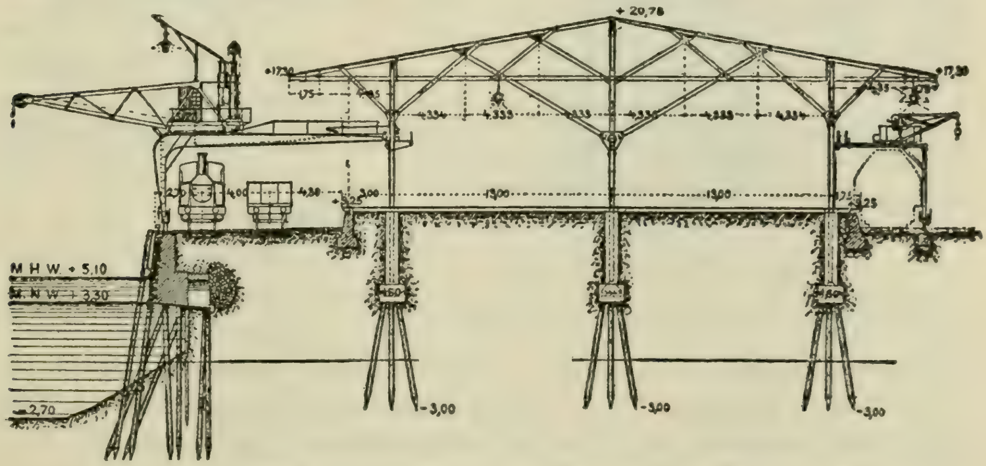


SHED ON THE VERSMANN QUAY, HAMBURG.

and from ship to wharf are everywhere in use, and the general New York conditions may be taken as typical.

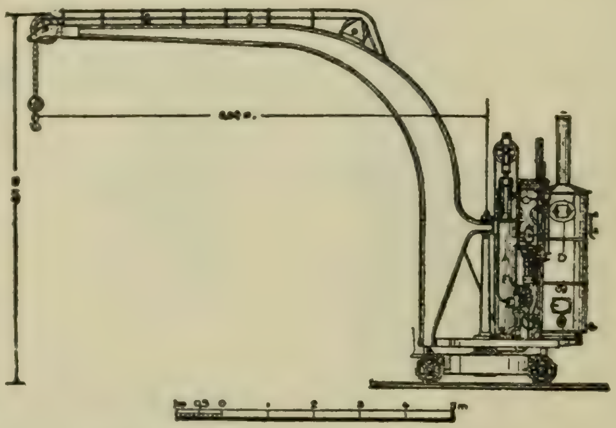
There are said to be now about 55 miles of wharf-room on the 20 miles of water-front that have been developed on Manhattan Island alone, afforded by 276 piers: of these the city of New York owns 151, of which only 51 are shedded, and 24 are owned in common, of which 10 are shedded.

A few of the private piers are provided with modern appliances, in the shape of coal-handling machinery and kindred plants; but nearly all, out of the entire lot, are destitute of everything except floor-space. This is a natural result of the prevailing system, whereby the city furnishes and builds the piers up to, and including, the floor, and leases them for a term of years to private parties; if the tenant desires sheds or other facilities, he provides them, as in the case of the



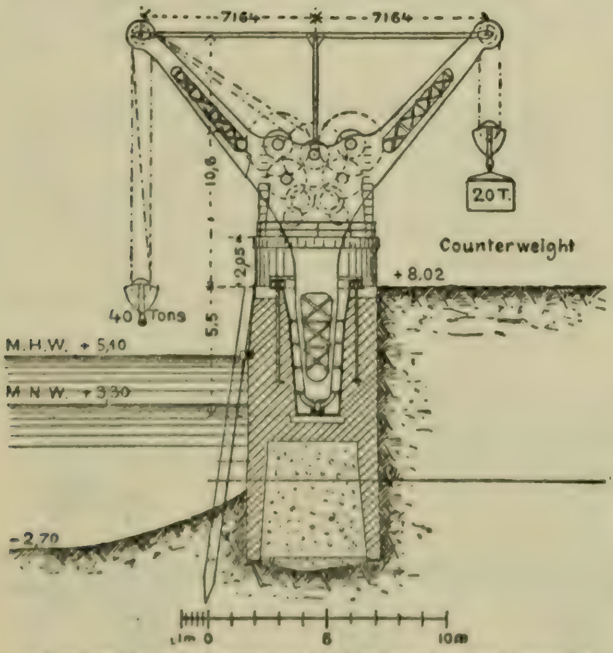
WHARF SHED WITH MOVABLE STEAM CRANE, HAMBURG QUAYS.

American line. There may be exceptions to the rule, but usually the buildings on piers are erected by the tenant; naturally only long-term leases justify such investments, and only comparatively few tenants can afford to make them.



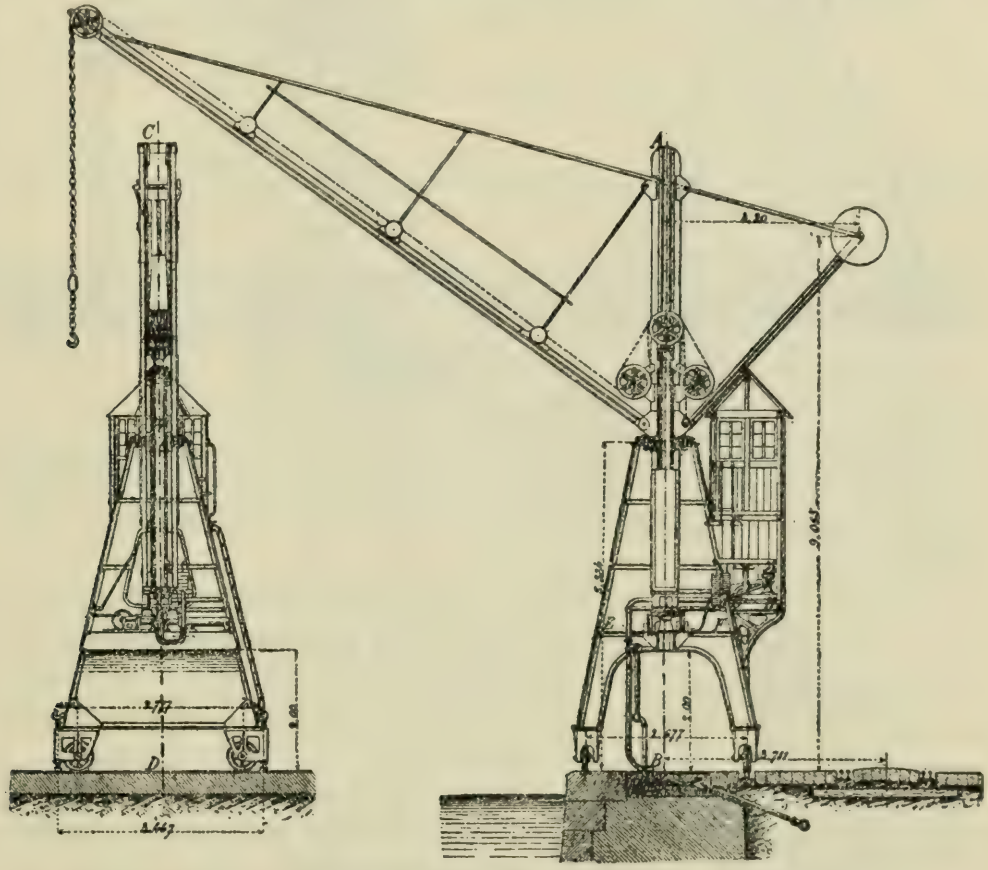
MOVABLE STEAM CRANE, HAMBURG.

Apart from that, the competition from other parts of the harbor, especially on the Jersey shore, where there are direct rail-connections with the trunk-lines, places another barrier in the way of enterprise. It is to be hoped, rather than confidently expected, that New York will soon awake from her long slumber, and assert herself in this direction; there are a few signs astir. Recently the board of consulting engineers to the dock department reported in favor of a proposed marginal railroad along a portion of the water-front, to be built and controlled by the city. Up to the present time a few piers only are so situated that they have rail-connection. In the second article of this series more will be said on this point.



HAND CRANE ON THE DELMANN QUAY, HAMBURG.

In marked contrast with this picture of backwardness, let us take a few examples of European ports. In Glasgow the harbor is an entirely artificial one, whose leading features are later to be described. There they actually have docks. The docks and quays are controlled by the Clyde trustees. The trustees provide no warehouses, but have some thirty acres of sheds for the accommodation of goods in transit; they do not load or unload miscellaneous cargoes, this being done by the ship-owners; but for coaling ships, hoisting heavy weights, etc., they have 42 steam and hydraulic cranes ranging in lifting power from 1½ tons to 75 tons, besides a 150-ton pillar crane capable of a lift of 100 feet from a depth of 20 feet below the quay to a height of 80 feet, with a working radius of 65 feet and a projection of 45 feet beyond its seat. In addition, there are 8¾ miles of harbor railway, connecting with the whole railway system of the United Kingdom. Berths are set apart for special tracks, and fully a half of the total quayage of 11,056 yards (6⅓ miles) is allocated to the leading lines of steamers trading to out-ports of Scotland, England, and Ireland; to the leading continental ports; to the British colonies, America, the East and West Indies, Africa, etc. The trustees permit ship-owners having allocated berths to place steam cranes on the breasts of the quays, and, when the report from which these figures are taken was compiled, there were 32 of them in use, ranging up to 30 tons' lifting power.*



HYDRAULIC CRANE, MARSEILLES.

It would be interesting, if space permitted, to compare the yearly

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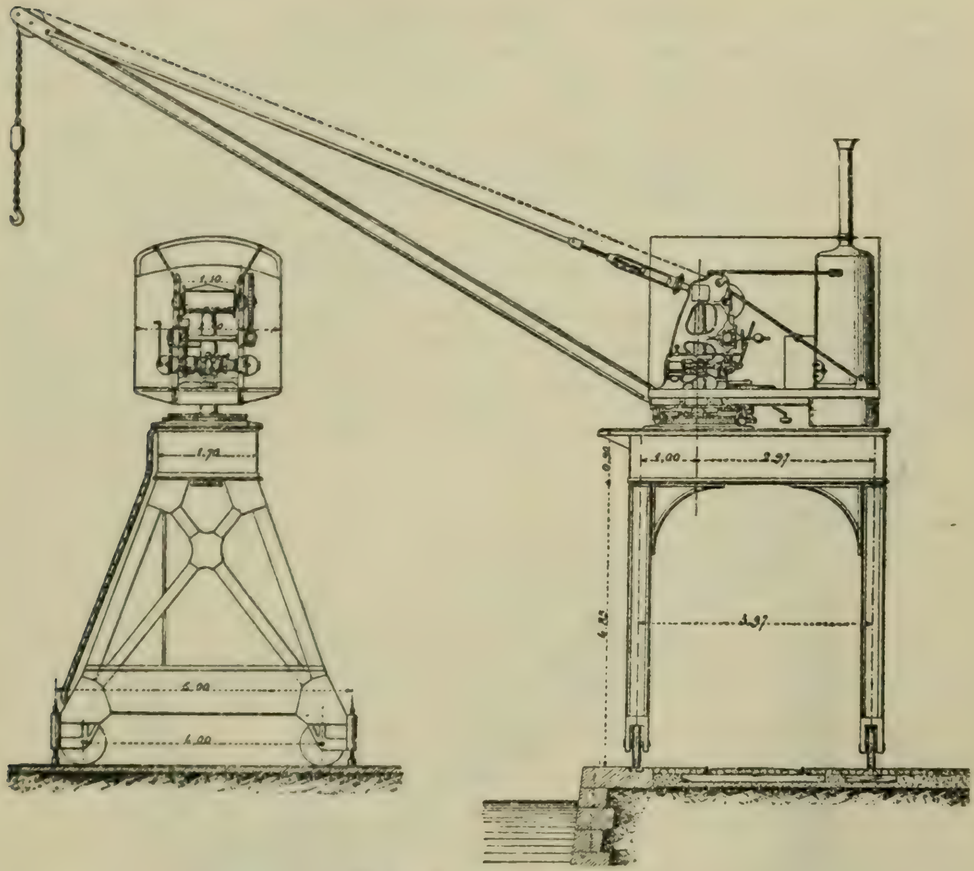
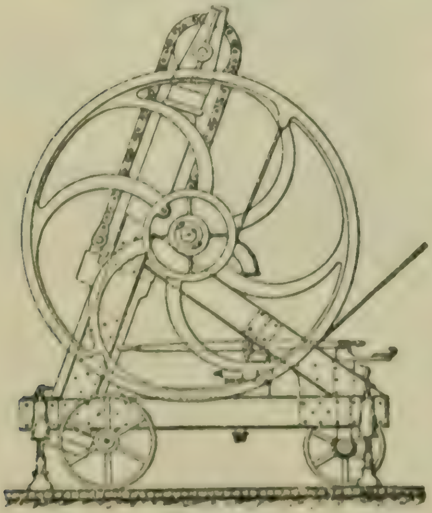
* Transactions Am. Soc. C. E., Vol. XXX.

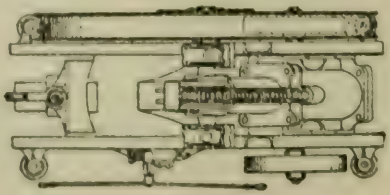


STEAM CRANE AT HAVRE.

results of operation, in tonnage and cost, of these six and one-third miles of highly-developed dock quays with those of the fifty-five miles of New York's "wharf-room."



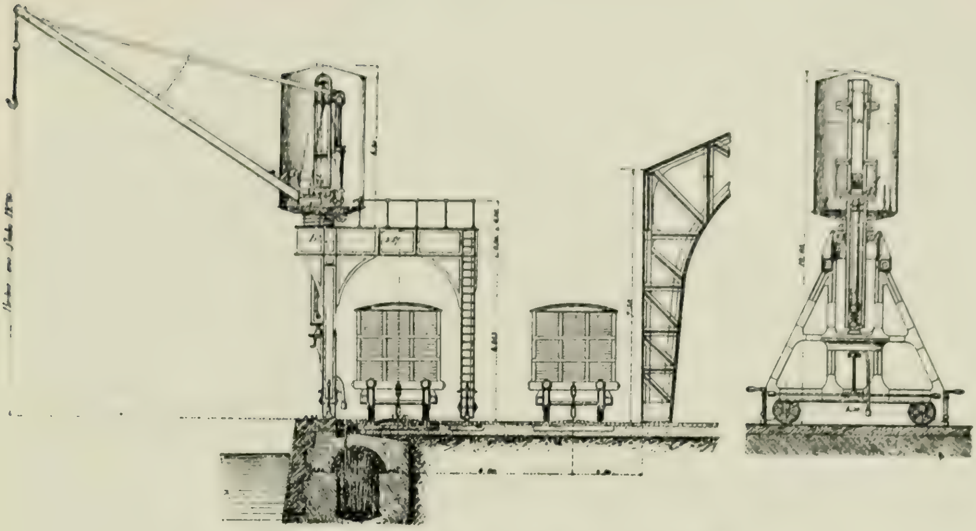
In the port of Hamburg there were, a short time ago, about the same length of quays as at Glasgow; they were found sufficient to discharge and load 3,758 ships in one year. On the Hamburg quays there were then working 66 stationary steam and hydraulic cranes, ranging in capacity from 1 ton to 150



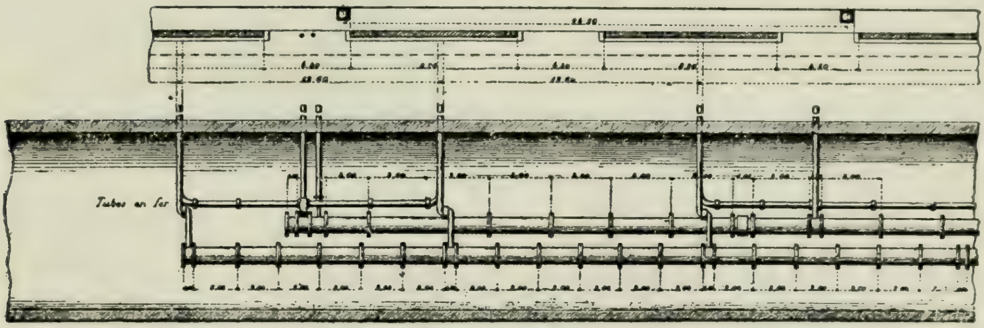
Elevation.

Plan.

HYDRAULIC HOIST, HAVRE.



HYDRAULIC TRAVELING CRANE AT HAVRE.

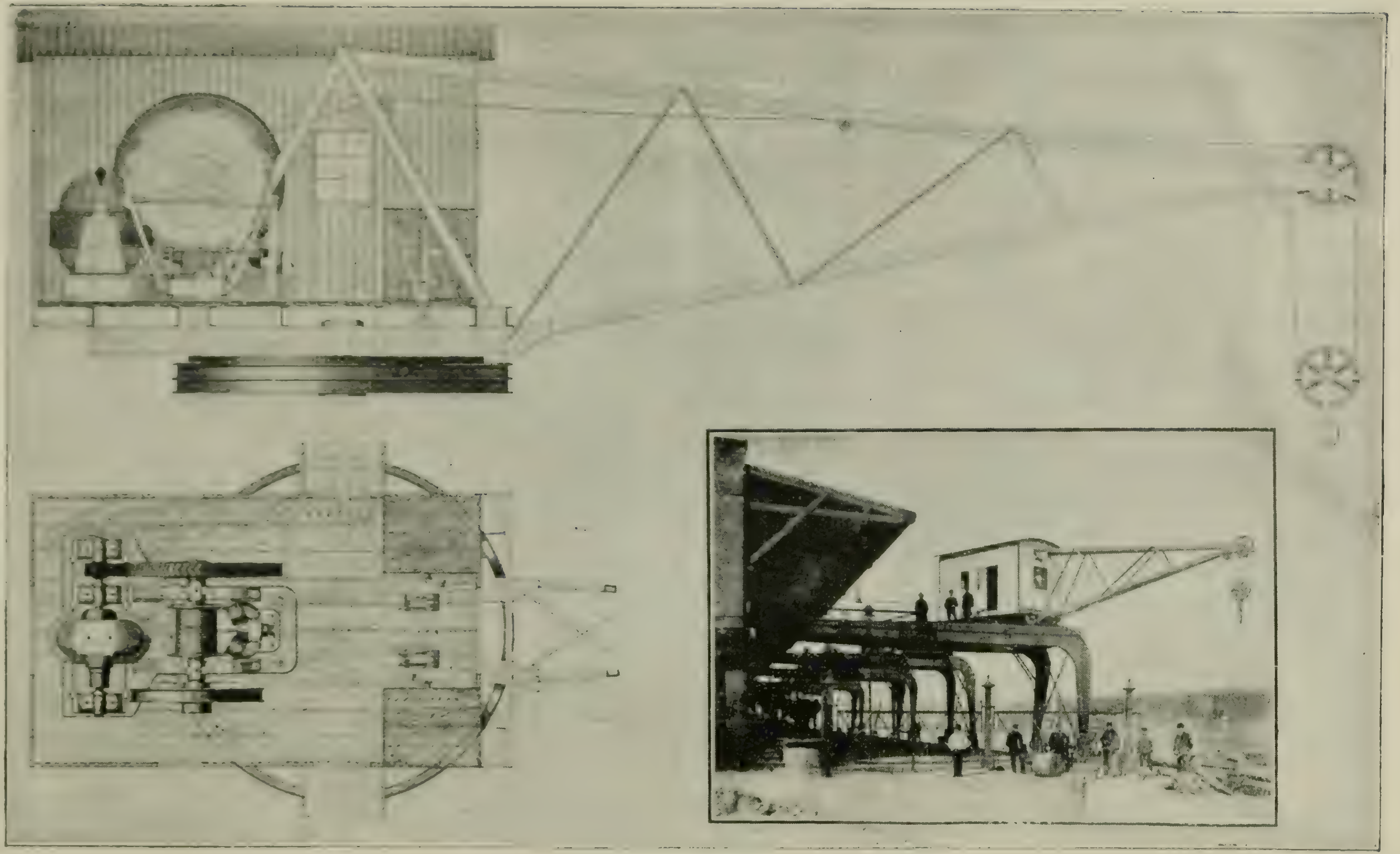


PLAN AND SECTION OF THE PIPE SYSTEM FOR HYDRAULIC TRAVELING CRANE SHOWN ABOVE.

tons, and 355 travelling cranes, mostly steam and electric. This makes a total of 421 cranes with a collective lifting power of about one thousand tons, which is more or less uniformly distributed along the quays, and gives an average lifting power of 60 pounds per foot of quay length.

Hamburg stands unrivalled in this respect, but throughout the ports of France we may find numerous fine examples, although the development has been slow, owing to peculiar conditions of administration. At Marseilles, Havre, Calais, and elsewhere the modern achievements have been very successful, especially in connection with the extensions of the railways to the quays, and with the very elaborate systems of sheds which prevail.

At Marseilles there are 9 locomotive cranes, capable of lifting more than 20 tons each, and a stationary, oscillating hydraulic shears of 120 tons, besides many floating derricks, of which the largest can



ELECTRIC CRANE ON THE PETERSEN QUAY, HAMBURG.

lift 60 tons. At Havre the number of large machines is more limited, but there are four notable ones, and many smaller hydraulic machines, owned and operated by a dock company.

The following table* gives the comparative situation, for the principal ports of France, of the development of the tracks, sheds, and machinery for loading and unloading in 1884 and 1893, and shows the activity which has been displayed during this period in the improvement of the plant at these ports.

PORTS.		Length of tracks on quays. Meters.	Area of sheds. Square meters.	Machines for loading and unloading.					
				Hand or steam.			Less than 3 tons.		
				100 tons and over.	20 to 100 tons.	3 to 20 tons.	Stationary steam.	Floating.	Hydraulic.
Marseilles	1884..	18000	62800	....	7	4	2	6	39
	1893..	43000	82000	1	8	6	1	7	85
Havre	1884..	20000	54000	1	2	8	5	4	....
	1893..	37000	108000	1	3	9	12	9	44
Dunkirk	1884..	15000	......	....	....	....	....	....	.... Projected
	1893..	35000	20500	....	2	1	19	9	21
Rouen	1884..	8500	......	....	1	2	13	22	...
	1893..	25500	12000	....	1	2	10	36	15
Bordeaux	1884..	14500	......	...	....	....	....	....	....
	1893..	16500	4800	....	1	....	24	....	....
St. Nazaire	1884..	3000	8000	....	3	2	16	7	....
	1893..	18000	9300	....	2	5	15	10	....
Dieppe	1884..	6000	2400	....	....	....	....	....	....
	1893..	10000	5300	....	1	4	29	....	....
Calais	1884..	35000	......	....	....	3	8	....	....
	1893..	21000	23000	....	1	5	8	....	16

As against all this, we have in the new world one conspicuous example, in the hydraulic oscillating shears of the Maryland Steel Company, at Sparrow's Point, Md., with a capacity of 125 tons and designed by Mr. Frank B. King. This machine is probably the very finest of its class in the world; it was used to land the great Krupp gun on its way to the Chicago Columbian exposition, and it was and is the only permanent apparatus on the American side of the water that could land that weight. Its lift is 65 feet, in the clear, and it has a lateral motion, at right-angles to the face, of from 9 feet 3 inches inboard to 49 feet 6 inches outboard, measured from the heels of the front legs. These dimensions adapt it for use in shipping ordnance, locomotives entire, marine boilers, and marine engines of considerable size. Such

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* Transactions Am. Soc. C. E., Vol. XXX.

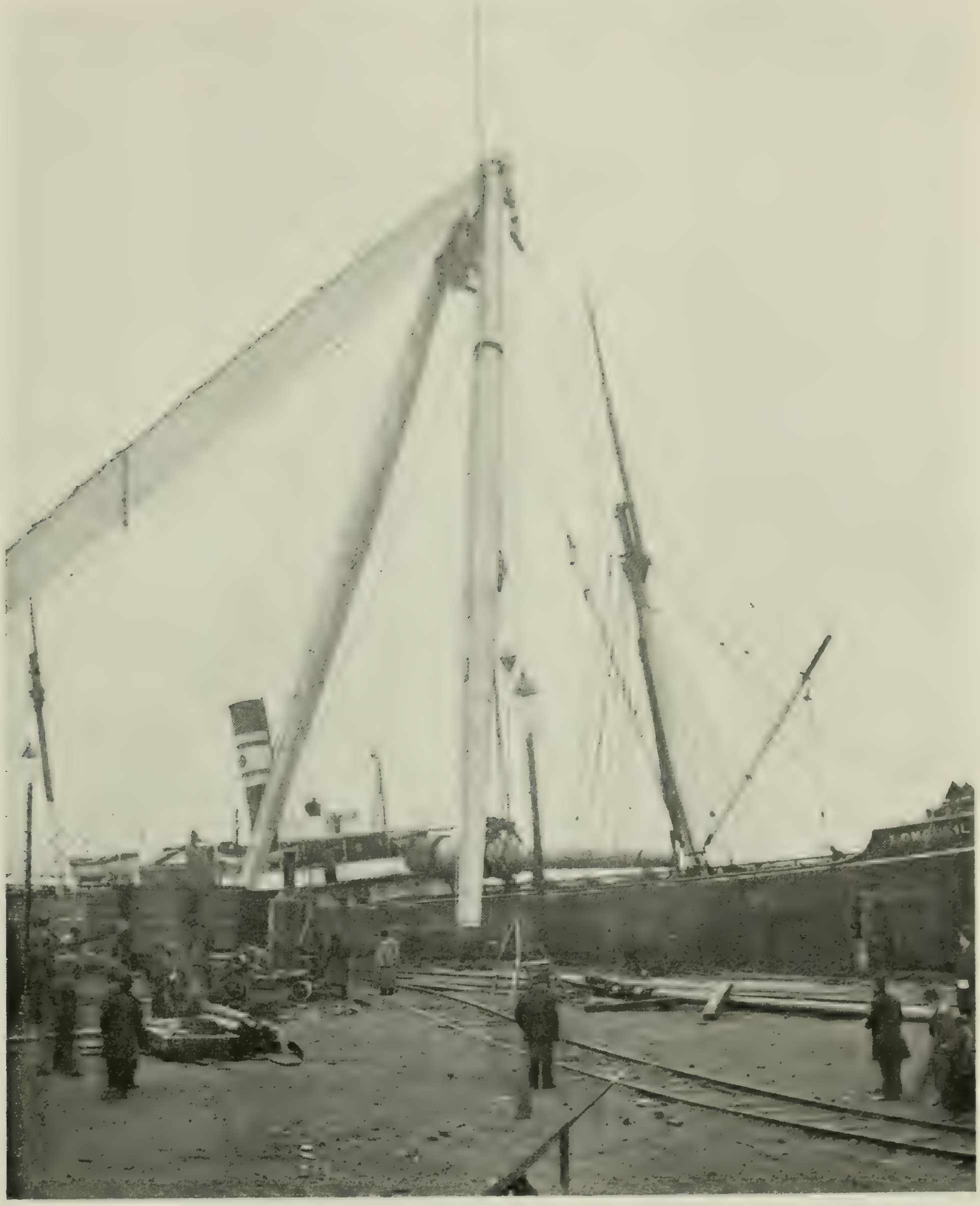
150 TON STEAM SWINGING CRANE IN THE SEGELSCHIFFHAFEN, HAMBURG HARBOR. THE HEAVIEST COMMERCIAL CRANE IN THE WORLD.

an apparatus is an essential in every well-furnished port, if there is to be development of the heavier kinds of manufacturing, and it would well pay any city to liberally provide such plant for its wharves.

It is only fair, when contrasting these fine examples of maritime commercial plant with the primitive, ungainly, and frightfully expensive methods on the American side of the water, to bear in mind the disadvantages which have existed, in New York city more particularly, and which have stood naturally in the way of development.

In the first place, we have the principal cause, already suggested, of the absence of American vessels in foreign trade ; it is not to be expected, perhaps, that the same careful provision will be made for foreign vessels that would be made for our own, if we had them, even though the ultimate cost and loss fall upon us, and though the present system of giving up un-needed miles and miles of water-front is so inconvenient, ugly, and detrimental.

In the second place, we have the almost insurmountable obstacle of "politics," which in New York places the development and care of the wharf system in the hands of a dock board, as a reward for party services its members could not have rendered had they been endowed with the proper qualifications and trained for this very important task. This remark is general ; it is not meant for an attack on the present members of the board (Republicans), or their predecessors (Democrats); it is aimed at the system, so prevalent in America and the Transvaal, but nowhere else, of putting public improvements in the hands of commissions and boards of "business men," instead of



THE 125 TON OSCILLATING HYDRAULIC SHEARS OF THE MARYLAND STEEL CO., BALTIMORE HARBOR, UNLOADING THE KRUPP GUN.

From a photograph in the collection of Mr. Stephen W. Baldwin.

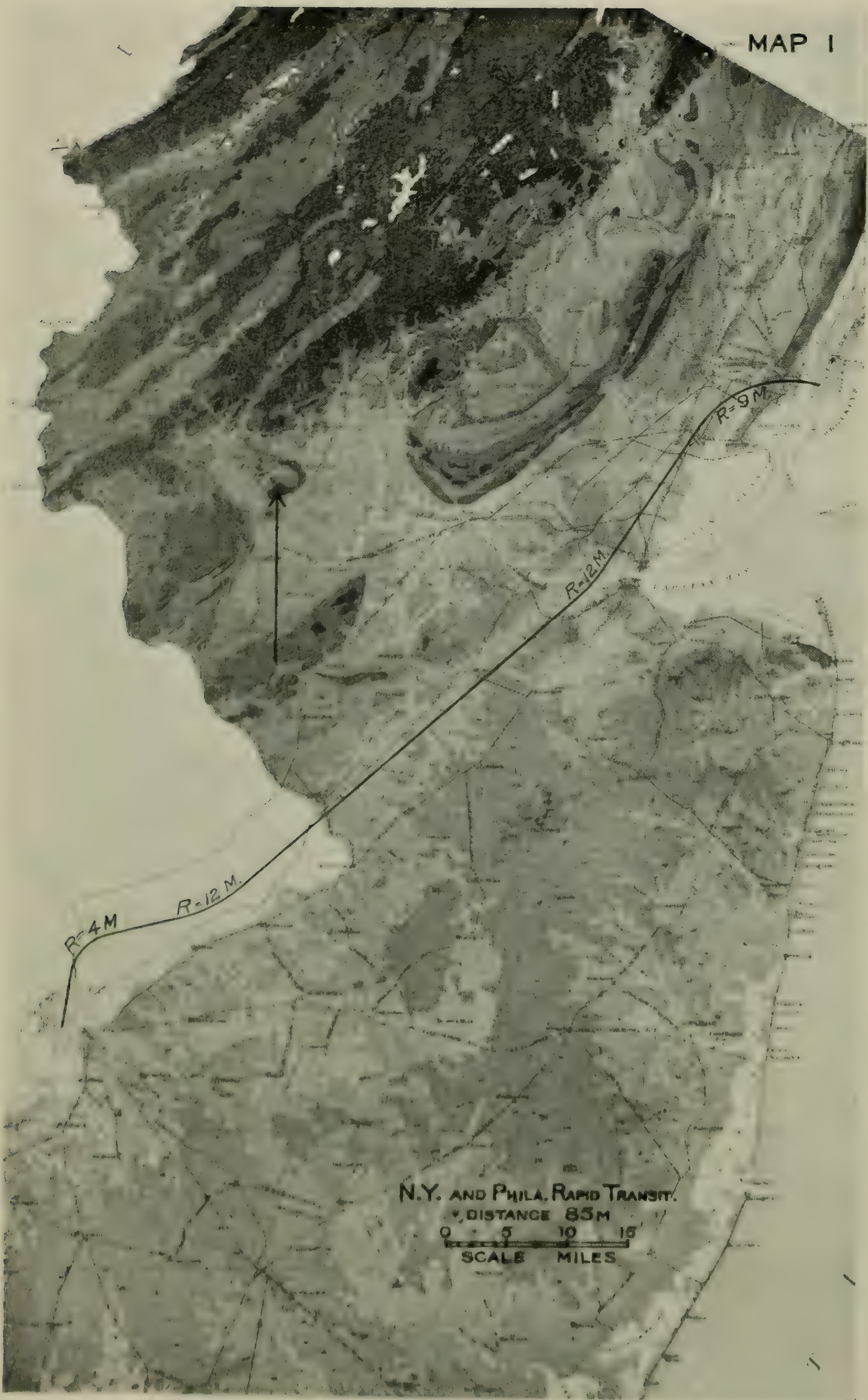
directly into the hands of those who possess the knowledge and skill to design and execute the works. What is always done in private enterprises is exceptional in public ones, and there, in a word, is the reason for American public imbecilities and mediocrities. Not long ago a very important bridge was to be built, and, as usual, the grocery stores and counting rooms were being searched for "suitable" men to appoint upon the commission. A friend of one of the appointing powers suggested that, out of the half dozen or so, two should belong

THE WATER FRONT OF ANTWERP.

to the profession of civil engineering. The reform mayor brought his fist down hard and forcibly, and said no! there should be no engineers on any commission, if he could help it. Until the country outgrows such ignorance as that remark laid bare, perfection in public works need not be looked for.

In the third place, it is extremely questionable whether, even under enlightened direction, it would be possible to produce as good results in providing dock facilities under the city's direct management as if the matter were left to private enterprise,—of course, under proper civic control as to certain points. In the case of the superstructures erected by the great steamship companies upon the city piers this seems to be admitted, even by the New York dock department. To go a step farther, and give free scope to intelligent and active competition in planning and utilizing the wharves, would doubtless revolutionize the business of commerce; and doubtless, too, in that case New York would soon have a very considerable mileage of superfluous wharves on her hands, unless the commerce of the port should increase commensurately with the increase of capacity of the individual wharves due to the higher development. There would then be room for other use of the magnificent water-front; it could be made beautiful and attractive and charming and healthful, as in the more civilized places of the world, instead of what it is.

The illustrations on pages 20 to 26 of this article were reproduced from the Transactions of the American Society of Civil Engineers.


MAP 1

R=9M.
R=12M.
R-12M.
R=4M
N.Y. AND PHILA. RAPID TRANSIT.
DISTANCE 85M
0 5 10 15
SCALE MILES

THE ENORMOUS POSSIBILITIES OF RAPID ELECTRIC TRAVEL.

By Charles Henry Davis and F. Stuart Williamson.

I.

IN THE ENGINEERING MAGAZINE for May and June, 1897, appeared an article entitled "Electric Traction under Steam-Railway Conditions." One of the conclusions reached was that electric motors could be used more profitably than steam "where higher speeds are required than can be attained by steam locomotives"; it is the purpose of this and the succeeding paper to show, by discussing a specific case, the possibility of producing, by the use of electric motors, a speed supposed to be thought of only by visionary people. The present paper will discuss the engineering problems involved and the possibilities of their solution; the second will show the approximate cost, and the possibilities of a return warranting the investment.

The special case chosen is the bringing of Philadelphia within thirty-six minutes of New York harbor. The proposed road would connect a population of 1,500,000 with another of 4,000,000. The length of the line, as shown on Map No. 1, would be about 85 miles, so that an average speed of 141⅔ miles per hour (2.36 miles per minute) would be required in order to accomplish the distance in 36 minutes. Allowing six minutes and 8.49 miles (44,827 feet) at either terminus within which to get up and reduce speed, the rest, 68.02 miles (359,146 feet), would have to be made in 24 minutes, or at the rate of 170.05 miles per hour (14,964.4 feet per minute = 249.4 feet per second). The proposed car, shown on Plates No. 1 and 2, would weigh about 150 tons when loaded to capacity. On a grade of one-fifth of one per cent. such a car would offer a resistance, due to the grade, of 4 pounds per ton, or a total of 600 pounds per car, equal to 272 h. p. at 170 miles per hour; our ruling grade has been taken at $\frac{1}{5}$ of 1 per cent. (except in one case, shown on Map No. 2, where the distance is so short that the excess can be neglected). Map No. 2 gives a profile of the proposed line; Map No. 3 (in sections) shows the proposed line on a scale giving a rough idea of the details of topography, railroad and road-crossings, rivers and streams. These maps have been made from United States government and State surveys, and are only approximate.

To accomplish its purpose the proposed road must take the minimum time, and make it with precision and safety and with great fre-

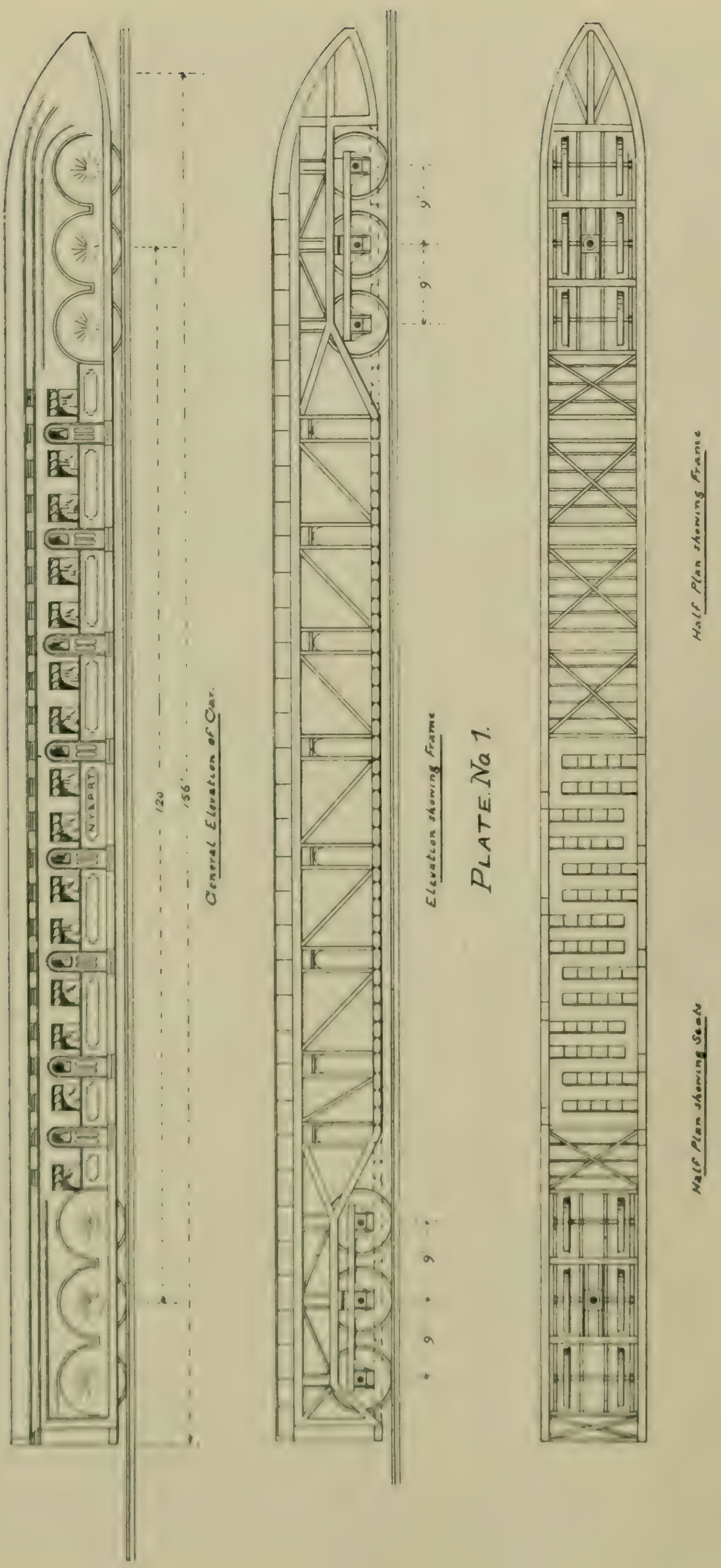

N.Y.&P.R.T.
120
156'
General Elevation of Car
9'
9'
9
9
Elevation showing Frame
Half Plan showing Frame
Half Plan showing Seats

PLATE No 1.

quency, for passengers must not be kept waiting at terminals; it will be admitted that, should Philadelphia be connected with New York by a time not exceeding that taken on the Brooklyn bridge, connecting New York with Brooklyn, and with a minute headway, there would be little doubt of the success of the road performing the service. Therefore high speed, frequency, and safety, providing the road can offer low fares, are the objects to attain, irrespective (at the moment) of constructive cost.

In discussing the engineering problems let us divide our subject under the following headings:

FIRST COST:

RIGHT OF WAY AND REAL ESTATE.

CONSTRUCTION.

1. Engineering and surveying. 2. Clearing. 3. Grading, ditching, etc. 4. Tunnels. 5. Masonry, culverts, bridges, trestles. 6. Fencing, cattle guards, road-crossings. 7. Ballasting. 8. Ties. 9. Rails. 10. Track-laying, lining, and surfacing.

(electric) 11. Rail bonding.

(electric) 12. Overhead trolley line, or third rail.

13. Signals. 14. Telegraph. 15. Stations and all buildings (including buildings for central power stations of electric roads). 16. Terminals.

EQUIPMENT.

(steam) 1. Locomotives and tenders.

(electric) 2. Motor cars or electric locomotives. 3. Passenger cars. 4. Freight cars.

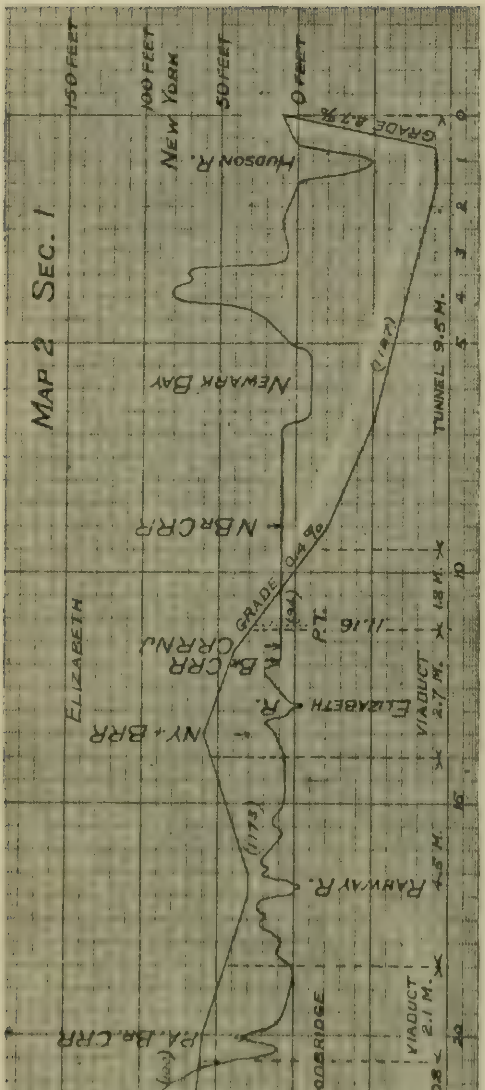
(electric) 5. Electric feeder lines and ground return circuit.

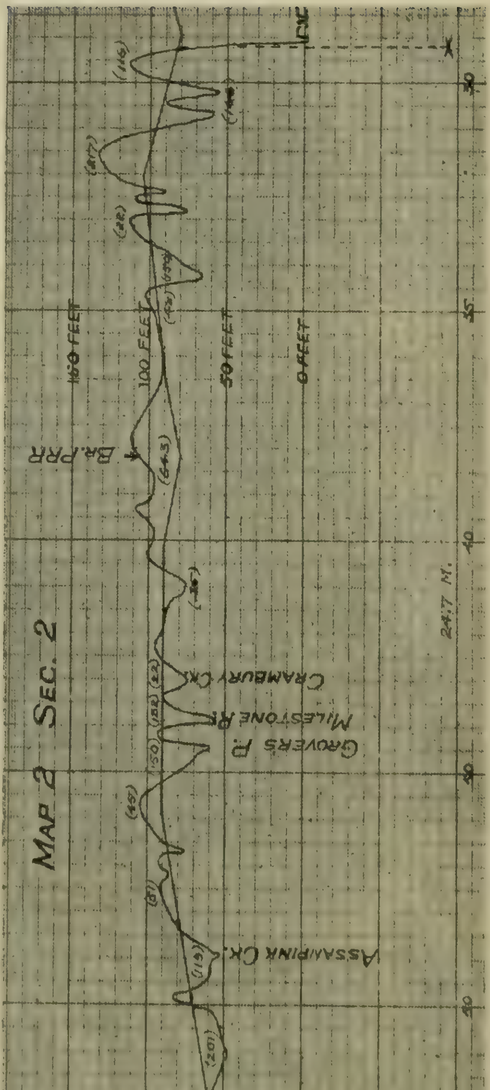
(electric) 6. Central power stations (not including buildings which are considered under "Construction").

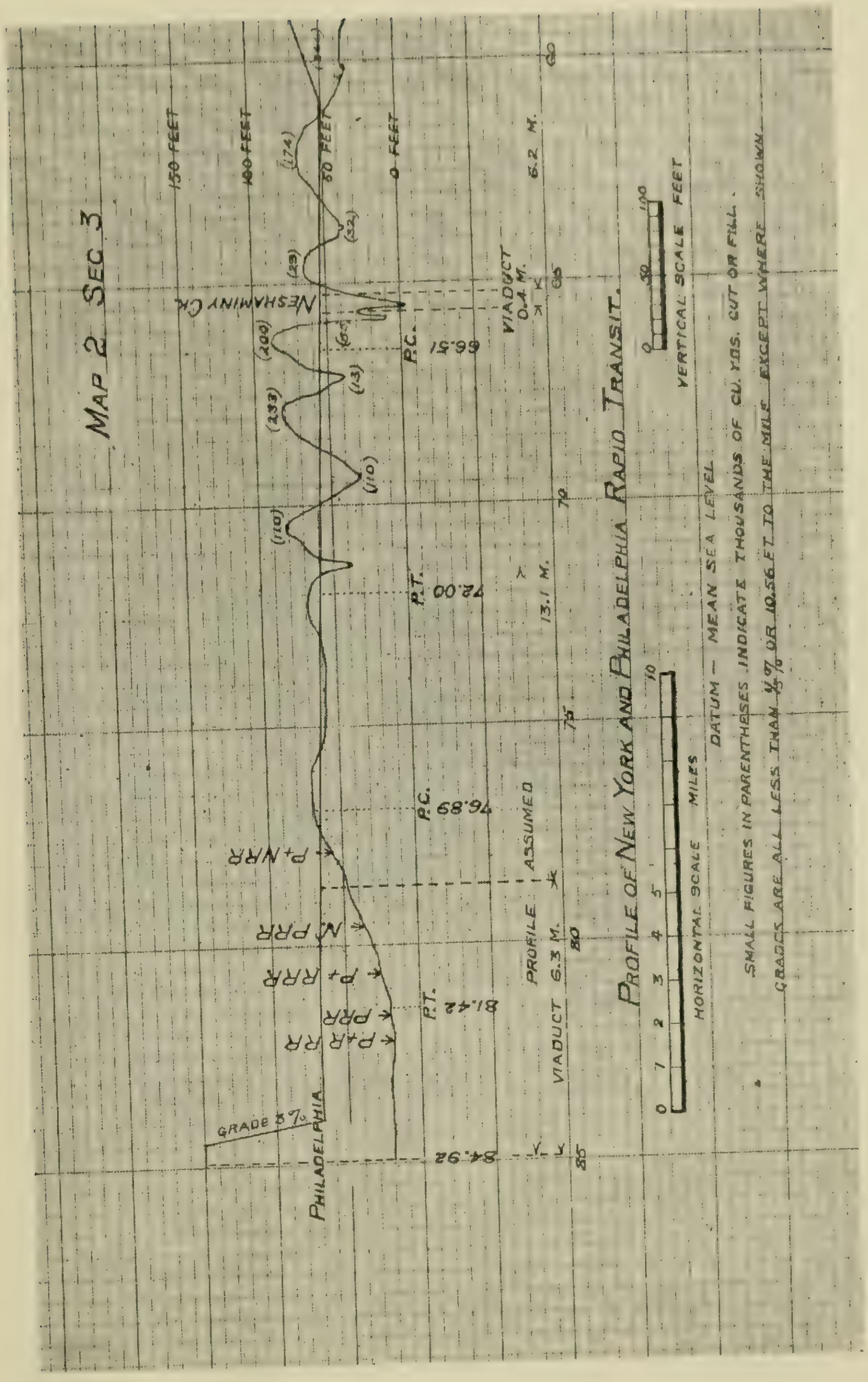
GENERAL.

1. Discount on bonds. 2. Interest on bonds to opening of road. 3. Taxes to opening of road. 4. Office expenses, salaries, etc., to opening of road. 5. Contingent and miscellaneous not itemized, to opening of road.

Right of way and Real estate relate only to cost; under "Construction," items No. 1, 2, 3, 4, 6, 11, 14, and 15 will not affect the solution of the problem, as the cost is the only element involved; let us, then, examine in detail the other items under this division. Item No. 5, so far as masonry and culverts are concerned, depends upon the cost alone. Bridges and trestles must be built to carry uniform moving loads of one ton per foot of single track. The load is concentrated, 75 tons resting on each 18-foot wheel-base, and the shortest distance, center to center, between any two wheel-bases is 30 feet. These loads do not exceed those now carried, but the proposed speed is much higher. It is apparent, however, that by reducing (if this were necessary) the span between piers or bents we can provide against any vibratory action which might cause trouble on existing bridges at such


MAP 2 SEC. 1
150 FEET
100 FEET
NEW YORK
50 FEET
0 FEET
HUDSON R.
GRADE 2.2%
NEWARK BAY
(1.87)
TUNNEL 9.5 M.
N.Br.C.R.R.
GRADE 0.4%
ELIZABETH
C.R.R.N.J.
Br.C.R.R.
P.T.
11.16
1.8 M.
NY+B.R.R.
R.R.
ELIZABETH
VIADUCT 2.7 M.
(1.173)
RAHWAY R.
4.5 M.
WOODBRIDGE
VIADUCT 2.1 M.
R.A.Br.C.R.R.
TUNNEL 1.7 M.
0.8
0.2
L.V.R.R.
(1.59)
P.C.
84.11
RARITAN R.
P.C.
86.78
VIADUCT 5.9 M.
0
1
2
3
4
5
10
15
20
25


MAP 2 SEC. 2
150 FEET
100 FEET
50 FEET
0 FEET
(115)
(217)
(22)
Br.P.R.R.
(64.3)
24.7 M.
CRAMBURY CK.
MILESTONE R.
GROVER'S R.
(45)
(150)
(182)
ASSANPINK CK.
(119)
(201)
(275)
TRENTON
CANAL AND T.Br.P.R.R.
DELAWARE R.
CANAL AND P.R.R.
VIADUCT 5 M.
30
35
40
45
50
55



PROFILE OF NEW YORK AND PHILADELPHIA RAPID TRANSIT.

HORIZONTAL SCALE MILES

VERTICAL SCALE FEET

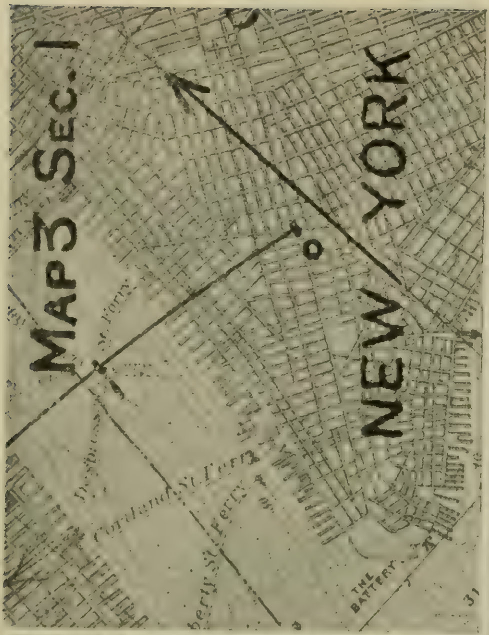
DATUM — MEAN SEA LEVEL

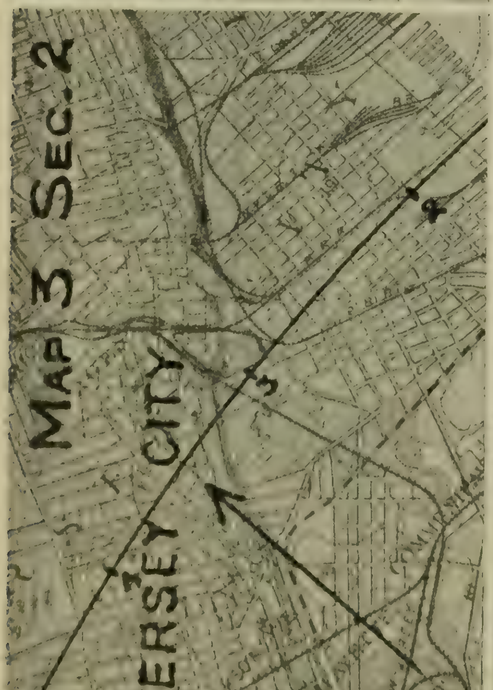
SMALL FIGURES IN PARENTHESES INDICATE THOUSANDS OF CU. YDS. CUT OR FILL.

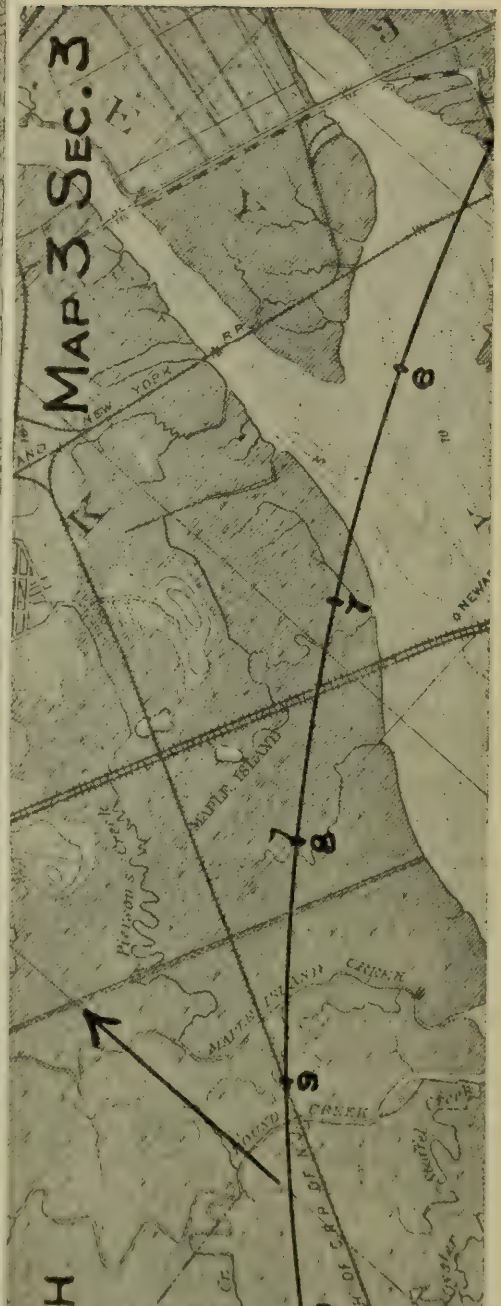
GRADES ARE ALL LESS THAN 1/5% OR 10.56 FT TO THE MILE EXCEPT WHERE SHOWN.

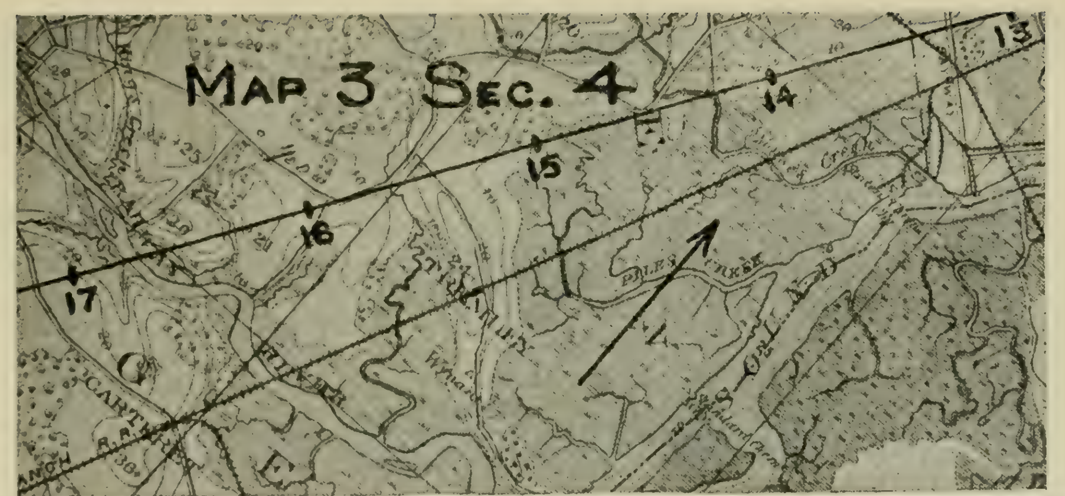
a speed. Of course there should be no grade-crossings. Items No. 7, 8, 9, and 10 can be discussed together. The lowest possible train resistance is a necessity in order to maintain the high speed required and to keep within a reasonable horse-power limit. A rigid road-bed is the only means of accomplishing this. A rail high in carbon and correspondingly hard, with a thin, broad head, nine to twelve inches deep, and patterned somewhat after the recommended standard of the American Society of Civil Engineers, but wider and thinner in the head, would, if properly supported, give a longer life than existing rails even with the proposed weights and speeds. The fiber stress of the steel would not be exceeded, and the high speed would be of advantage, as the hammer-blow of reciprocating parts would not exist with gearless electric motors. The stiffness of such a rail would be more than six times that of our highest and heaviest existing rails. The weight of this rail would be about 250 pounds per yard. Each rail being sixty feet long, the total weight would be 5,000 pounds. Gage might be standard or even broader. The importance of preventing the rails from spreading or breaking would probably require the use of braced steel chairs. Metal ties, laid two feet from center to center, carrying four rails, so as to give the maximum stability vertically and laterally, could be used ; rail joints could be of girder and double angle plate pattern, giving even greater strength and stiffness than the rail itself ; rails might be cut obliquely, to add to the ease of riding ; ballasting should consist of heavy broken stone on edge as a sub-base ; ties should be supported on concrete laid upon the layer of broken stone (after the practice of cable and underground electric roads) filled in and around, flush, with small, broken stone. Such a track would not be subject to the waves which are created before and after our existing trains, causing such destruction and excessive resistance. To reduce oscillation one rail could be slightly elevated the entire length of the line, probably reducing the train resistance as well as partly removing a motion disagreeable to the passengers. On the sharpest curve (4-mile radius, 16′-17′ angle of deflection) the elevation of the outer rail would not exceed 3.5 inches (really less than this, as the center of gravity of our car is about at the center line ot axles, 3½ feet above top of rail); these curves would offer little additional resistance (one 4-mile radius, one of 9 miles, and two of 12 miles, respectively 16′-17′, 7′-8′, and 5′-6′ deflection angles, and .06 ft., .027 feet, and .023 feet middle ordinates) over that of tangents, for their large radius and high velocity would tend to reduce it. Assuming, however, that it will not be materially reduced, present practice shows a resistance of about ⅓ of a pound per ton per degree of curvature, with track in good condition and trains at ordinary speeds, so that our 4-mile curve would have a resistance of 1·9 of a pound per ton, or a total of 16.6 pounds per car, equal to about 7.5 h. p. at 170 miles per hour, which is probably eliminated by the conditions stated above. Item No. 12 would of necessity be a "third rail." It could be placed close to the side of the car, elevated about two feet above the top of rails (three feet above top of ties) and supported on the ties as permanently and substantially as the other rails. Plate No. 2 shows a proposed method which would give the third rail perfect alignment and surface; this rail could be of steel and supplied with current from the feeder system, carried between the tracks as shown. The contact shoes could be carried from the trucks on a lever swinging from a center 3½ feet from the top of rails; springs would hold the shoes below the center and against the third rail, or, if the shoes were thrown up by an obstacle and the springs passed the coincident line of the lever, it would hold the shoes from the third rail until they were put down again by the motorman. This device could be patterned somewhat after the one in use on the Brooklyn Bridge. There seem to be no great difficulties in the use of such a third-rail system, or in collecting any amount of current requisite even at the high velocity of operation. The next item, No. 13, covering the signal system, is of the greatest importance, and in some respects the most difficult to solve; on such a road, operating trains at 170 miles an hour, or 249.4 feet a second, equal to 2.853 miles a minute (14,964.4 feet per minute), our system of signaling must be perfection itself; it must be automatic, not only in giving a danger-signal to the motorman, but in making it impossible for him to obtain power from the third rail when the signal is at danger, and, in addition, must put on his brakes, if he fail to do so himself; furthermore, it must be of such a nature that any fault in any link of the system will throw everything to danger.

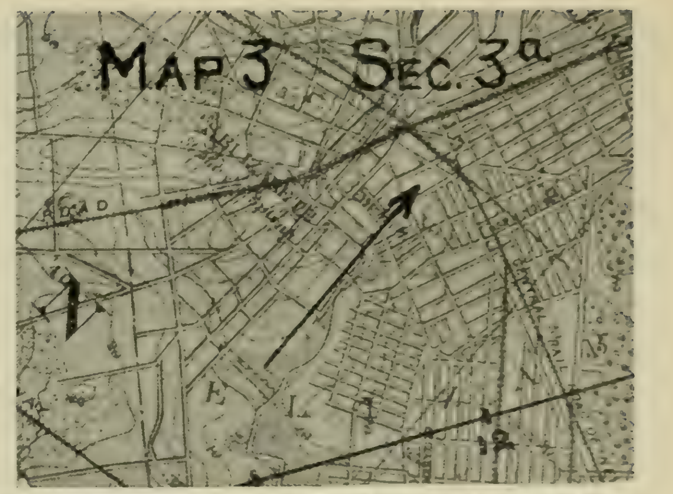
A suggestion of such a system is outlined in Plate No. 3. The heavy base line indicates the track; a-b, b-c, c-d, etc., are sections, each of a length not less than the distance which the fastest train would cover in the least allowable headway; while the smaller subsections, a-x, x-y, y-z, z-b, etc., are of such length that any train running at its maximum speed can stop within any sub-section without injury to the passengers. At "a," "b," "c," "d," etc., are signal towers, and at "x," "y," and "z" distance signals operated from the following tower. In the signal towers would be the power stations or sub-stations for distribution and control of the current to the third rail. The horizontal line of numerals indicates the first, second, third, and fourth position of trains as they enter and pass

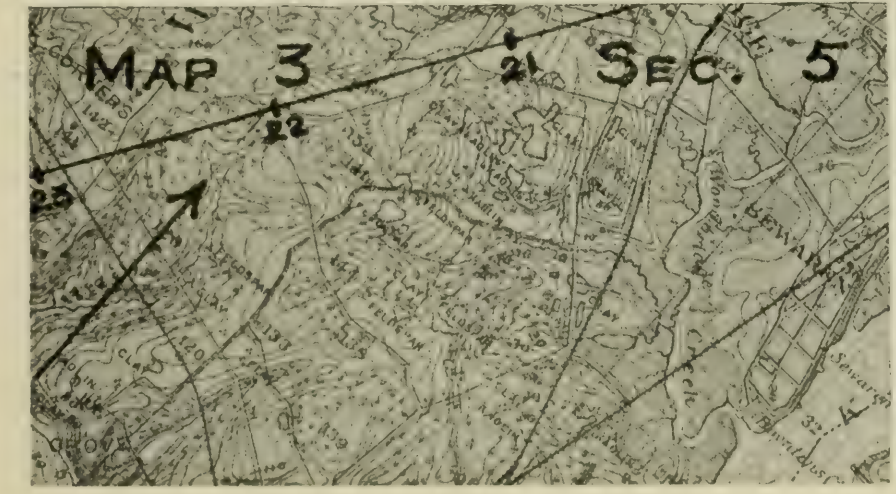

MAP 3 SEC. 1
NEW YORK
Cortland St. Ferry
Liberty St. Ferry
THE BATTERY

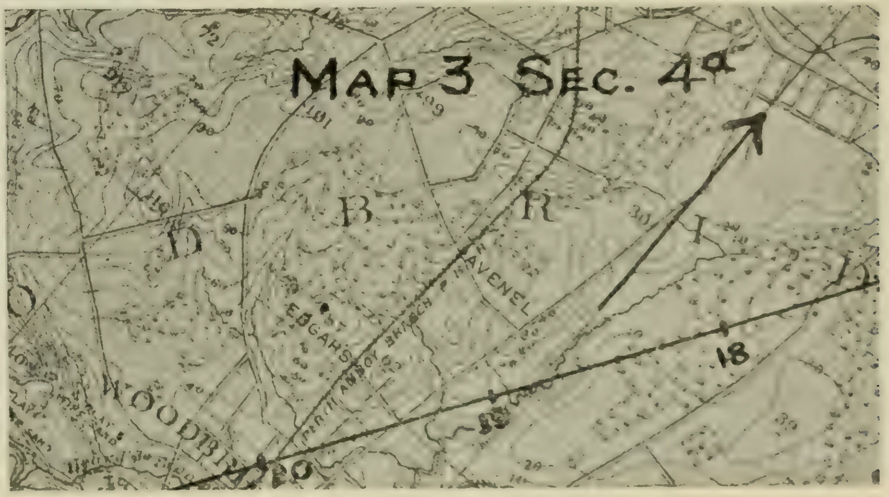

MAP 3 SEC. 2
JERSEY CITY
3
4
5

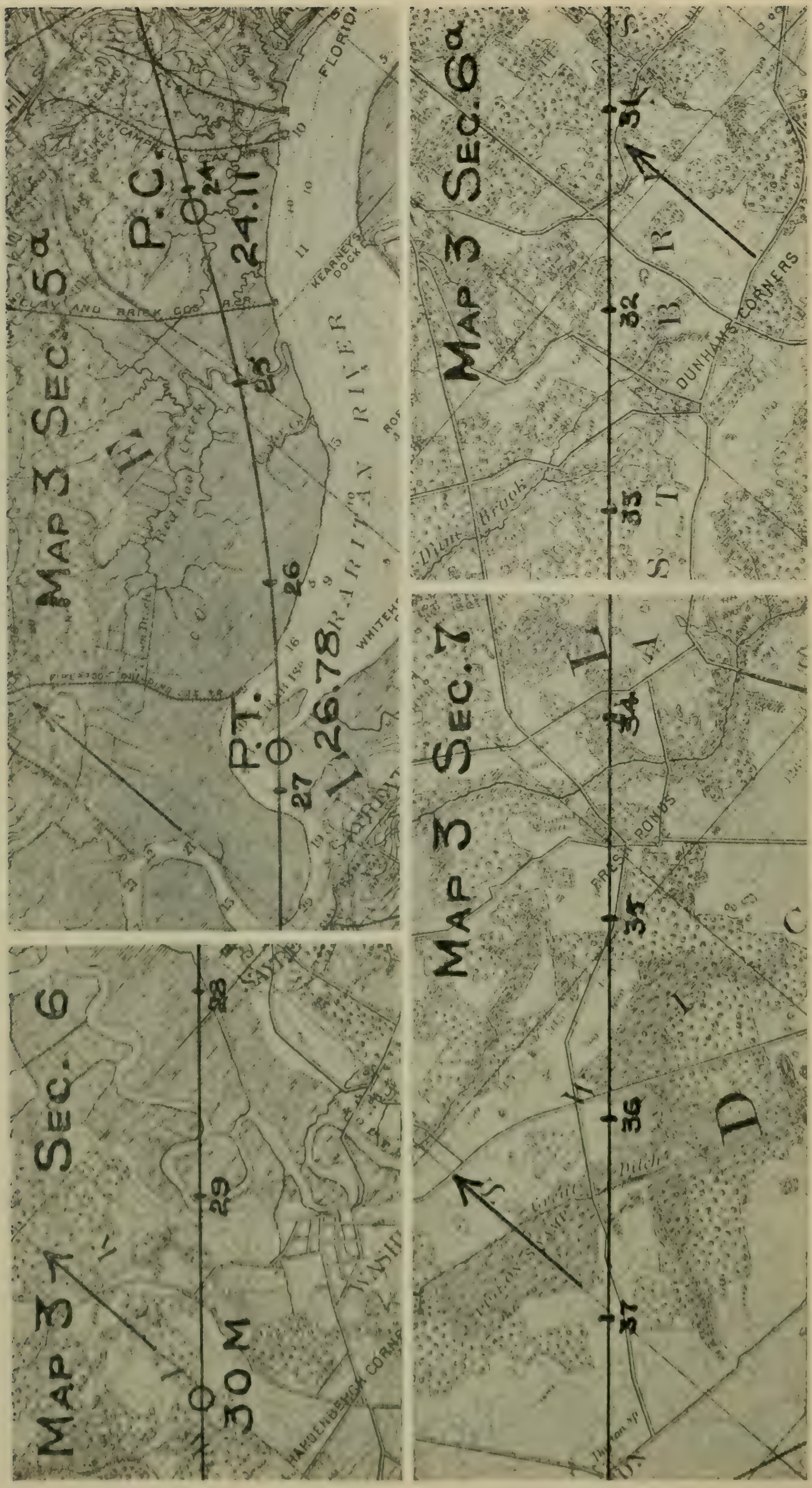

MAP 3 SEC. 3
ELIZABETH
P.T. 11.16
6
7
8
9
10
NEW YORK R.R.
MAPLE ISLAND
MAPLE ISLAND CREEK
Peirson's Creek
NEWARK BRANCH OF C.R.R. OF N.J.

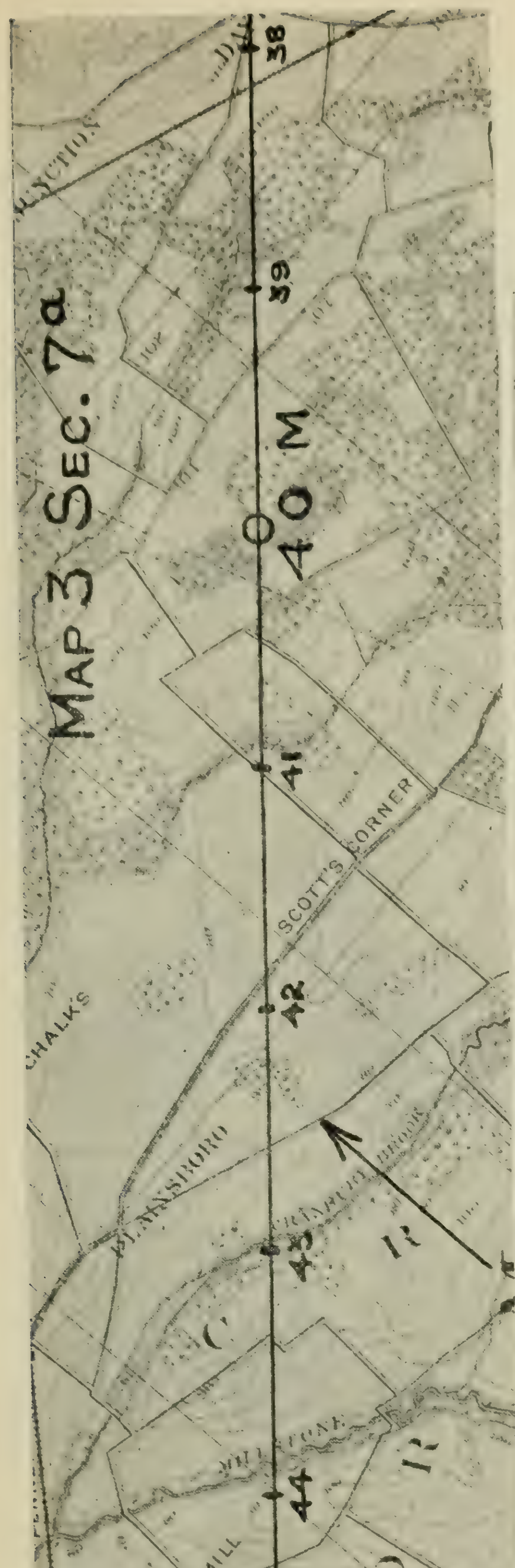

MAP 3 SEC. 4
13
14
15
16
17

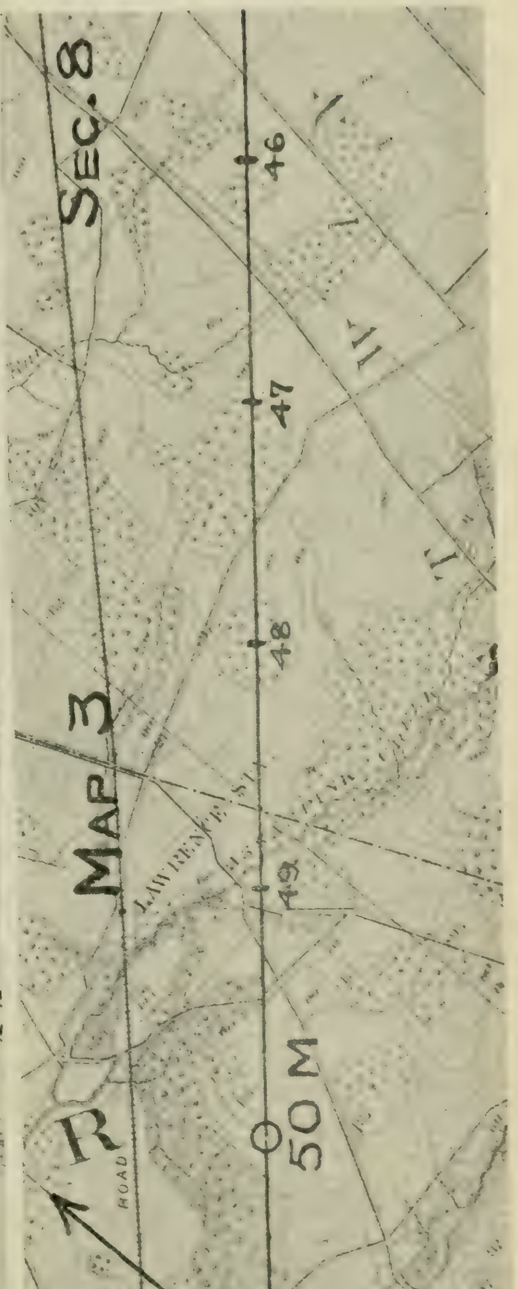

MAP 3 SEC. 3a
12

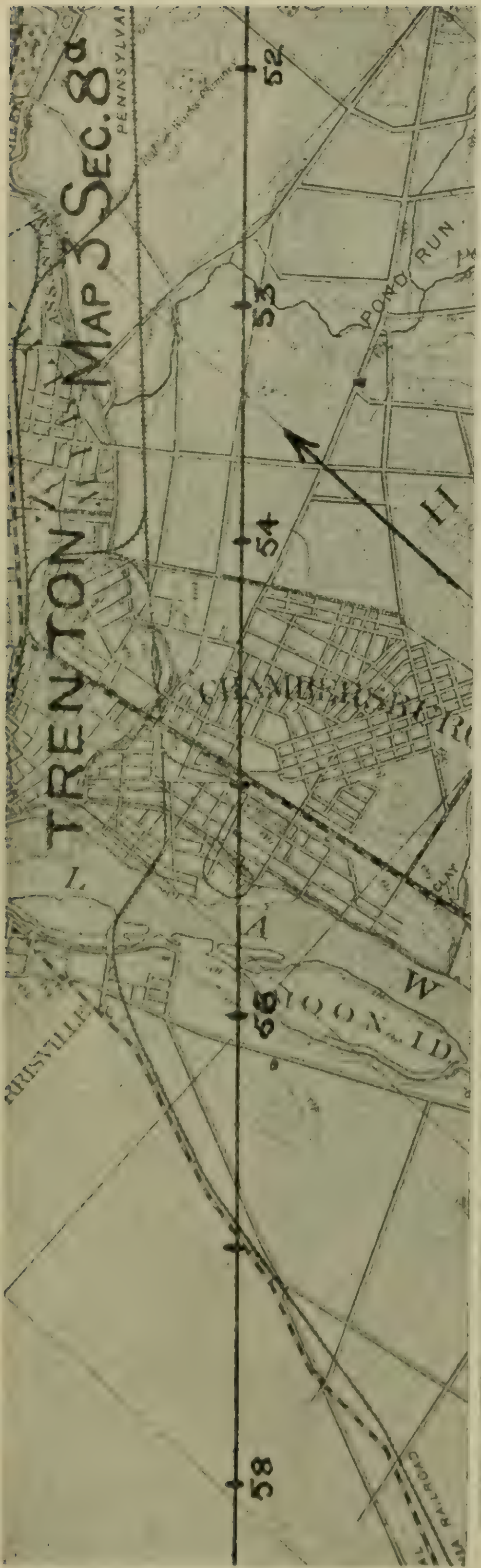

MAP 3 SEC. 5
21
22
23

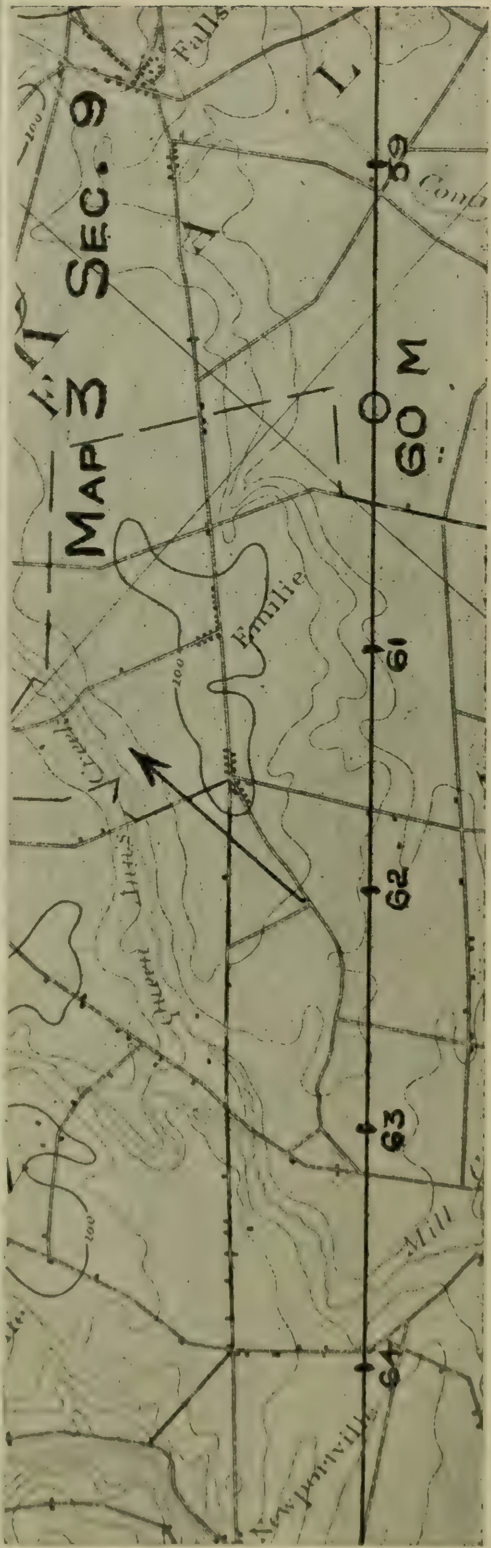

MAP 3 SEC. 4a
18
19
20
WOODBRIDGE
AVENEL

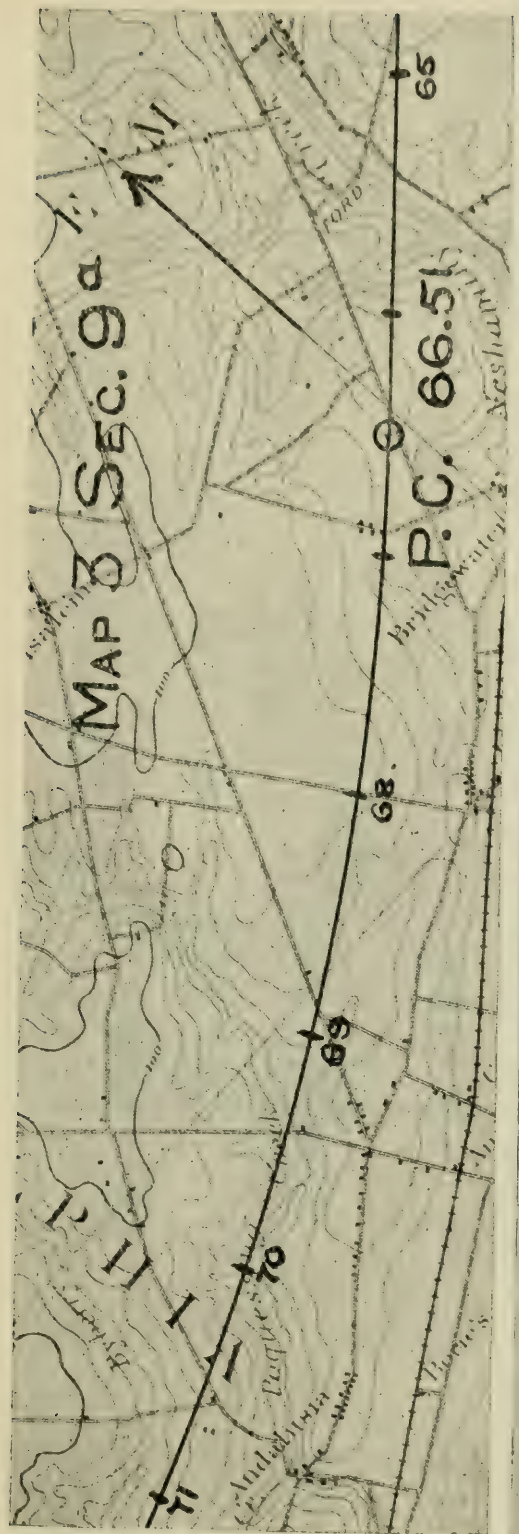

Map 3 Sec. 5a
P.C.
24.11
P.T.
26.78
24
25
26
27
Raritan River
Red Root Creek
Kearney's Dock
Florida
Clay and Brick Cos. R.R.
Map 3 Sec. 6
28
29
30 M
Hardenbergh Corner
Map 3 Sec. 6a
31
32
33
Dunhams Corners
Map 3 Sec. 7
34
35
36
37
Fresh Ponds
Pigeon Swamp

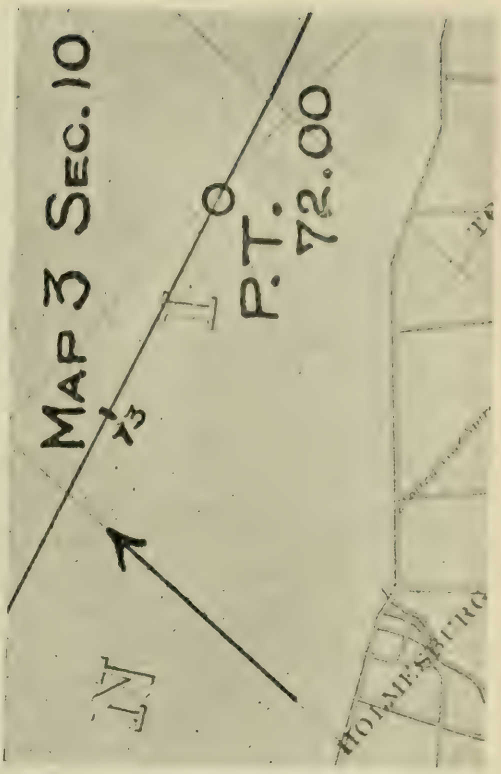

MAP 3 SEC. 7a
38
39
40 M
41
42
43
44
45
SCOTT'S CORNER
CHALKS
PLAINSBORO
CRANBURY BROOK
MILLSTONE
GROVERS MILL
JUNCTION
C
R
O
S
D

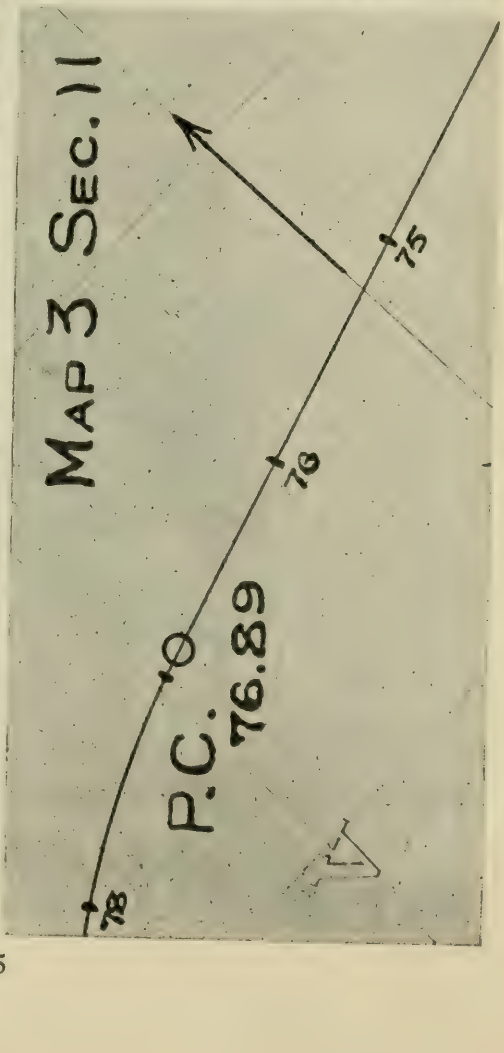

MAP 3 SEC. 8
46
47
48
49
50 M
51
LAWRENCE ST
R
ROAD
RAIL

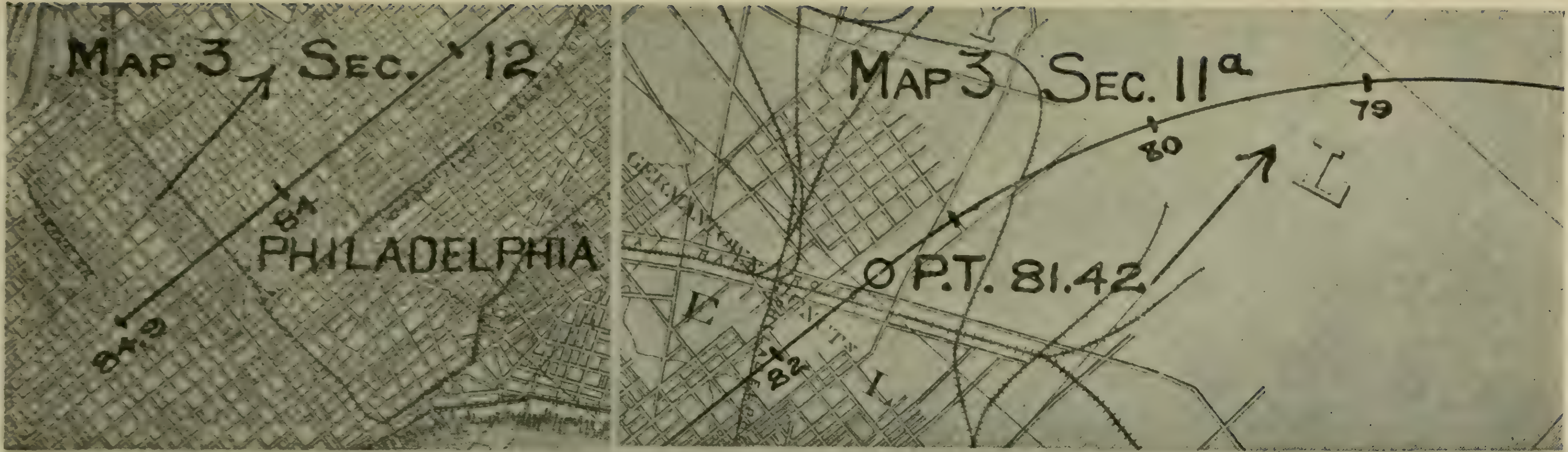

MAP 3 SEC. 8a
TRENTON
CHAMBERSBURG
PENNSYLVANIA
POND RUN
52
53
54
56
58
H
W
L
A
MOON ID
RAILROAD


MAP 3 SEC. 9
59
60 M
61
62
63
64
Falls
Emilie
Mill
Newportville
L
H
100


Map 3 Sec. 9a
P.C. 66.51
65
68
69
70
71
N
Ford
Neshaminy
Bridgewater
Poquessing
Philadelphia


Map 3 Sec. 10
P.T. 72.00
73
N
Holmesburg


Map 3 Sec. 11
75
76
P.C. 76.89
78
N



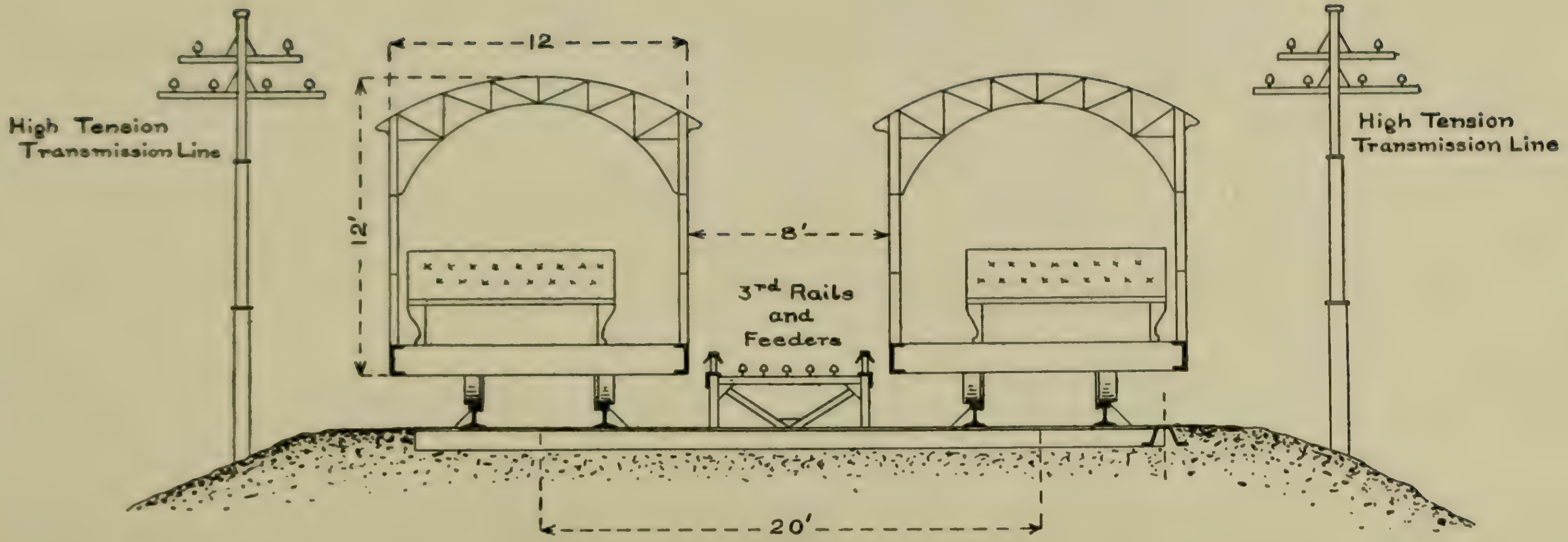
N.Y.+P. R.T.

DETAIL SECTION MAPS OF PROPOSED ROUTE

STATION POINTS, FROM N.Y. TO PHILA.,
ONE MILE APART ARE INDICATED IN SMALL FIGURES.
ARROWS SHOW NORTH AND SOUTH LINE.
CONTOURS 10 FT. APART. SCALE ONE MILE TO AN INCH.

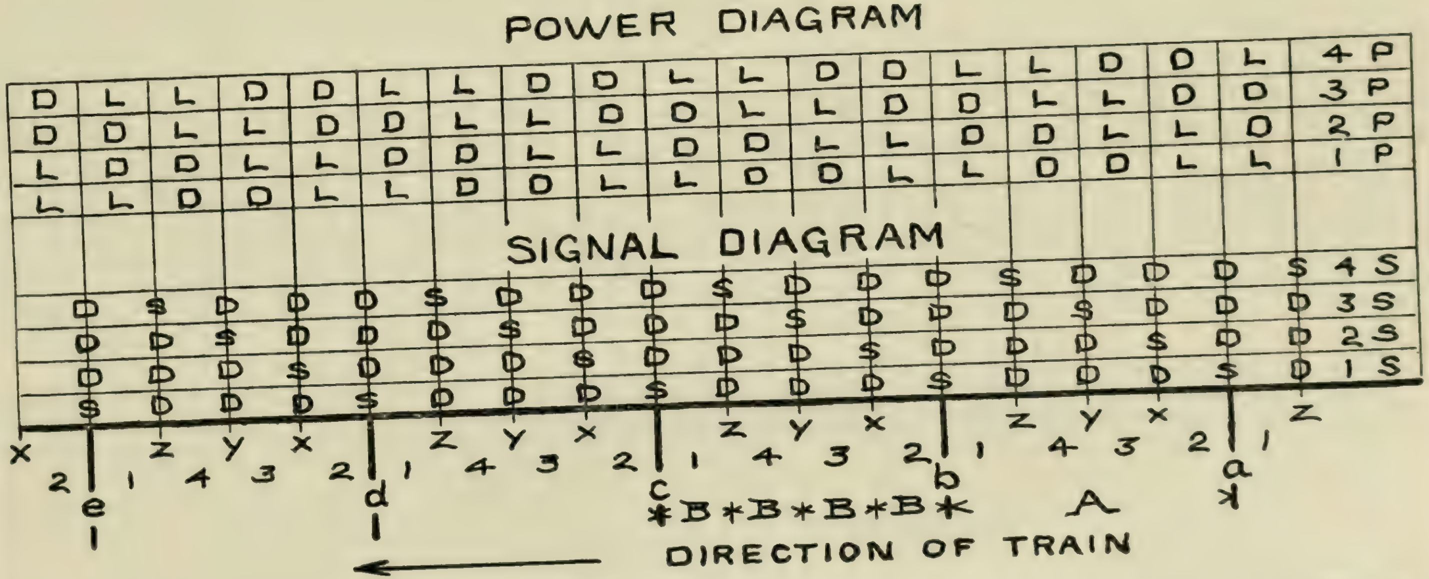
through the blocks controlled by towers "a," "b," "c," and "d"; the letters "S" and "D" in the first five horizontal lines show whether the signal at that point is at "Safety" or at "Danger"; while the numerals "1s", "2s", "3s", and "4s" are opposite the successive lines corresponding to the successive positions of each train, 1, 2, 3, and 4; similarly the letters "L" and "D" in the second five horizontal lines show whether that section is "Live" or "Dead," with corresponding reference numbers "1p", "2p", "3p", and "4p." The towers are interlocked, so that "S" cannot be shown at "a-x" until "D" has been shown at "b," nor can "S" be shown at "a-y" until the two sections each side of "b" are made "dead." It will be noticed that the section upon which a train is running and the one immediately ahead always have current, while the two sections directly following a train are always dead; there are also three danger signals behind every train. The interlocking would be so arranged that signals behind a train could not be thrown to "S," until the train had passed out of the section, thus always maintaining signals and current connections as shown in the diagram. It will at once be seen that the capacity of a given track, in number of trains, depends upon four times the length in which a train can be stopped, without danger to the passengers. This distance might have to be a greater multiple, six or eight; our succeeding article will consider this question. The system of signals suggested does not involve mechanism or methods not already found reliable and satisfactory; they are, however, applied somewhat differently. In the plan proposed, if a signal should go to danger, it would show the ordinary semaphor or light (at night), and at the same time it could have a device, to be operated from the passing motorman's cab, to give him warning. Setting the signal to danger would also throw into place a rod close to the third rail, somewhat like the safety rods used with interlocking signals and switches of to-day. This rod would have a long gradual incline approach, and project above the third rail sufficiently to throw up the sliding shoes past their center, so that the springs would hold them clear of the third rail, thus cutting off the power. The motorman's ampere indicator would also warn him. By a similar device, on entering a dead section, should the engineer have failed to apply his brakes at the first signal, a lever could be thrown, opening a valve similar to the present "conductor's valve," thus applying them automatically. Some such automatic combination must be relied upon to make the road safe, with no possibility of rear end collisions. Under item No. 16, covering terminals, we have a very important problem to solve. The units will be heavy, will arrive at high speeds, and must get under way and up to speed quickly; they must

Plate 2



Cross Section.

PLATE 3


POWER DIAGRAM
SIGNAL DIAGRAM
x 2 e 1 z 4 y 3 x 2 d 1 z 4 y 3 x 2 c 1 z 4 y 3 x 2 b 1 z 4 y 3 x 2 a 1 z
*B*B*B*B*
A
DIRECTION OF TRAIN

D	L	L	D	D	L	L	D	D	L	L	D	D	L	L	D	D	L	4 P
D	D	L	L	D	D	L	L	D	D	L	L	D	D	L	L	D	D	3 P
L	D	D	L	L	D	D	L	L	D	D	L	L	D	D	L	L	D	2 P
L	L	D	D	L	L	D	D	L	L	D	D	L	L	D	D	L	L	1 P

D	S	D	D	D	S	D	D	D	S	D	D	D	S	D	D	D	S	4 S
D	D	S	D	D	D	S	D	D	D	S	D	D	D	S	D	D	D	3 S
D	D	D	S	D	D	D	S	D	D	D	S	D	D	D	S	D	D	2 S
S	D	D	D	S	D	D	D	S	D	D	D	S	D	D	D	S	D	1 S

DIAGRAM OF COMBINATION BLOCK SIGNAL AND CURRENT SYSTEM

N.Y. + P.R.T.

B = n FEET

A = m FEET = 4 B

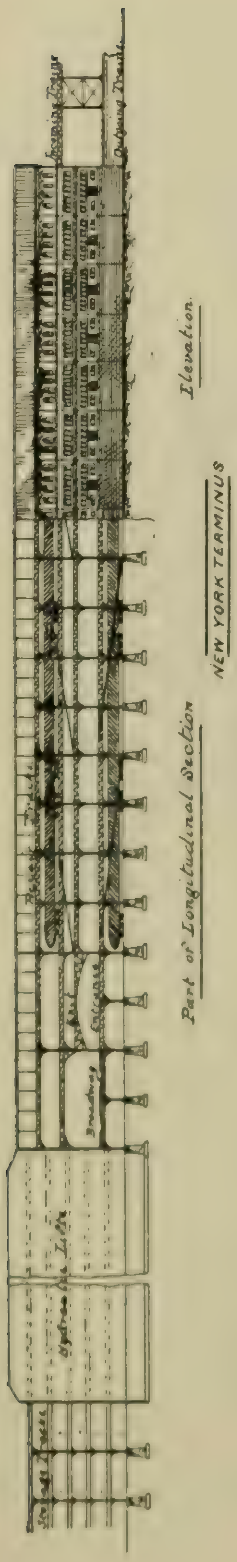


PLATE No. 4

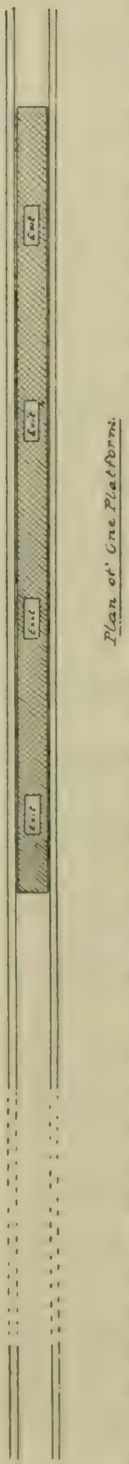


PLATE No. 5

arrive and depart very frequently, and large crowds must be handled promptly and without confusion. To accomplish all these points requires that trains should arrive in one part of the station and depart in another; they must arrive and depart in rotation and always on the same track (also necessary to avoid accidents); passengers must move in the same general direction and forward, after once alighting or after entering the station for departing trains; these streams must never meet; passengers should always move on a level or down inclined planes; steps should never be used, and, if passengers must move upward to any extent, it should be by elevators. Such a terminal is suggested in Plate No. 4 (half elevation and longitudinal section) and Plate No. 5 (plan of one platform). The incoming tunnel would rise above the outgoing to the level shown; passengers would move down inclined planes and along to passageway to streets. The incoming train, after discharging its load, would move onto the hydraulic or electric lift and pass down to the level of outgoing tracks, or up to repair shops, or across to storage tracks; there could be one lift to each track. The outgoing passengers would enter the waiting-room at the street-level and pass down inclines to departing trains.

It seems from the foregoing that there are no difficulties in respect to safety or durability of track sufficiently serious to prevent the attainment of a speed of 170 miles per hour. Our next problem is that of "equipment."

The feeder lines and ground return circuits could all be along the lines of present practice; our rails could, with their bondings, form the return circuit, reinforced, if necessary, by copper return feeders and connected by the metal ties. The outgoing and return transmission system could feed with multiphase currents to the signal towers at high potentials over wires carried as shown on Plate No. 2. At the signal towers rotary transformers could convert the current to direct, and then feed over copper wires to the various sections, the feeder switches being interlocked with and operated by the signal levers. Five central stations, situated respectively 6½, 24½, 42½, 60½, and 78½ miles from the New York terminal, could provide the power. Thus there would be a station close to the two points of maximum acceleration each 6½ miles from a terminal, or power stations could be located at signal towers omitting sub-stations. These power plants could be built according to modern practice, and could be tied together for the purposes of relay. It seems unnecessary to go into detail, as it is not suggested that present practice should be materially departed from. As this road will not carry freight, we need not consider item No. 4. Items No. 2 and 3 can be taken together, as every car should be a motor car capable of moving itself at the speeds required. Each car in a train would be like every other, except that the front and rear cars would carry at one end a hood or bonnet, as suggested in Plate No. 1, to reduce "head" and "tail" atmospheric resistance, and the front car would control the delivery of current to the motors. (It must not be inferred that the suggestion more than outlines a type which might have to be modified,—for example, by the use of guiding trucks.) The coupling and vestibuling of cars could be done by the present methods. The wheels being of large diameter (7 feet) and six to each truck, the cars should ride easily on such a track as the one proposed. These wheels could have wide treads and somewhat thicker flanges, of the depth of those now used, and could be built in sections to stand the high velocity. These wheels, at 170 miles per hour, would make 11.34 revolutions per second, or 680.4 per minute, which would not be excessive, so far as the motors are concerned. The axles could probably be made hollow, say 15 inches in diameter, with journals and boxes of the present standard; if the latter were made 10 inches long, the pressure would be only 166 pounds per square inch, though 200, or even 300, is allowed to-day with good results. Such wheels and axles should greatly reduce the rolling and axle-resistance of the train. The car might be, in general characteristics, like that shown in Plate No. 1, seating 140 passengers and having doors on both sides for rapid loading and unloading; the windows could be of heavy fixed plate glass, and ventilation could be secured at the top and ends as now, with the addition of openings along the sides, under control of the passengers, like registers in houses heated by hot-air furnaces. The doors could be opened and shut from the ends of each car by a lever system similar to that used on the Intermural Railroad at the World's Fair, and under the control of the guard in each car.

In our outline we have, thus far, good reason to think that a speed of 170 miles per hour or more can be attained and maintained without any danger or inconvenience to the passengers; but we now come to the really serious questions at issue,—namely, what will our train resistance be at this high velocity, what horse power will be needed to overcome it, and what will be the distance within which a train, moving at this speed, can be stopped without inconvenience to passengers? A volume might be written on the first of these; so we will deal first with the second. Allowing 90 per cent. of the weight to be applied for braking purposes and an efficiency of one-sixth with 2 pounds rolling resistance, such a car running at 170 miles per hour could be brought to a stop on a level track in about 9,910 feet with present-day brakes. Assuming uniform retardation, this would be 3.139 feet per second. With a double system of brakes and track brakes, the proposed car could no doubt be brought to a stop in a much shorter distance without danger to the passengers, although perhaps with some inconvenience.

Train resistance can be divided into the following headings:

1. Journal friction, between journals and bearings.
2. Rolling friction, between the wheels and rails (No. 1 and 2 are usually considered together).
3. Atmospheric head resistance.
4. Atmospheric tail resistance (suction).
5. Atmospheric side resistance.
6. Atmospheric bottom resistance.
7. Atmospheric top resistance.
8. Oscillation and concussion resistance, increasing the journal and rolling friction. (Nos. 3, 4, 5, 6, 7, and 8 are usually considered together).
9. Curve resistance.
10. Grade resistance.
11. Starting resistance.
12. Stopping resistance.

In considering this question, it must be remembered that the various recorded experiments differ widely, and show many seeming inconsistencies, as well as some real ones, and that many of the formulæ from reliable sources assume that "velocity resistance" is either all atmospheric or all oscillatory; furthermore, that these experiments have been made upon tracks and with rolling-stock which cannot be compared in character with those suggested, and have been conducted under the disadvantage of the locomotive's high resistance as compared with that of the train behind it. It is to be regretted that we have no more positive knowledge on this most important subject so far as it relates to very high speeds, and that, therefore, any conclusions we may come to must be more or less uncertain.

Taking up the resistances in detail (but not consecutively), we find first that experiments on European and American railways give journal and rolling friction from 2 pounds per ton as a minimum to 8 pounds as a maximum, the figures being based on axles averaging, say, 4 inches and wheels averaging 42 inches in diameter. These resistances vary directly as the diameters of the axles and inversely as the diameter of the wheels, and are not materially affected by the velocity; the lower limit would, give, therefore, a resistance of 2.7 pounds per ton for the proposed car, and the higher limit 10.9 pounds per ton. When it is remembered that the data we now have are for wheels, journals, rails, and track, any comparison of which with the proposed construction and equipment is like a comparison between one of our new western lines having 40-50 pound rails and a model English system having 100-pound rails, it is not unreasonable to predict that the resistance per ton of the proposed car will not exceed the lowest now known. It is not unreasonable because, though our records are from trucks, journals, wheels, etc., in fair condition for present practice, their maintenance is not up to the standard that will be absolutely necessary on the proposed road. We have already seen that the maximum curve resistance on the sharpest proposed curve will not exceed 7.5 h. p. per car ($\frac{1}{9}$ pounds per ton = 16.66 pounds per car). We have shown that the maximum grade requires 272 h. p. per car additional (4 pounds per ton = 600 pounds), which is partly balanced by the "velocity head" acquired by the train when running down grades; in our case, assuming the latter to be equal to $.04V^2$ (V = velocity in miles per hour; allowance being made for rotative energy of large wheels), we have, as a minimum from our profile for 20 feet vertical height, 22.3 miles per hour (89 h. p. per car, assuming 10 pounds per ton resistance), or, as a maximum for 40 feet vertical height, 31.6 miles per hour (126 h. p. per car, assuming 10 pounds per ton resistance, which is liberal). In starting the train it is proposed to have heavy down grades out of the terminal stations (these will also help retard the trains on entering), the one at New York about 100 feet fall and that at Philadelphia about 80 feet. These grades would respectively produce "velocities feet" of about 50 and 45 miles per hour, and, assuming each to be half a mile long, it would take approximately 72 and 80 seconds respectively to attain those speeds. The necessary horse power to maintain a velocity of 170 miles per hour would be far in excess of any power required to start the train from rest, even assuming that it would be 40 pounds per ton (it would probably be less than this, and almost wholly instantaneous in character). Stopping resistance has already been discussed. We now come to atmospheric, oscillatory, and concussion resistances (Nos. 3, 4, 5, 6, and 7).

These resistances, commonly called "velocity resistances," vary enormously, depending upon the formula; all experiments have invariably shown that at high speeds all formulæ known to the writers give far too high resistances,—⅓ to ½ too high at tested speeds, the errors being probably much greater for the high speed here contemplated. One source of error is the sometimes improper measurement of atmospheric resistance in pounds per ton; for, with the same surface exposed at a given velocity, this resistance would be the same, irrespective of the weight of the moving body. Some writers credit to oscillation and concussion two-thirds of the total velocity resistance, and claim that air has far less effect than is commonly supposed. Some of the high resistances known in present practice should not exist with rotative application of power. Every railroad man is familiar with the "racking" in locomotives produced by the thrust of the rods quartering on each other; the slight elevation of one rail would materially reduce the evil effect of oscillation, and the rotative application of power would reduce it still more. Atmospheric side, bottom, and top resistances are not of any great moment, except as effected by the velocity and direction of the wind; the atmospheric head resistance should be greatly reduced, for the proposed train would have no surfaces exposed between the cars. There being no platforms or means of passing from car to car, and no sharp curves, the ends could be brought close together, and the small intervening space could be closed by a flexible "vestibule" at sides and top and bottom. The shape of the front end of the first car and the rear end of the last car could be made so as to materially reduce resistance from these causes. The atmospheric bottom resistance of present practice, due to exposed mechanism of every kind, together with present trucks, which tend to pocket the air, could be reduced by the smooth plane surface running the entire length of the train, with openings for only the lower part of the wheels. Oscillation and concussion could be greatly reduced by precautions already suggested, and also by the greater rigidity and stability of the proposed track. Various formulæ give a variation of from 50 to 250 pounds per ton resistance for trains at the proposed speeds, or a variation of 3,400 to 17,000 h. p. for 150 tons (one car). The evidence seems to be strong that many existing formulæ are far from the truth, and that the resistance of the proposed train, on a line built as suggested, would be much less than many engineers now believe; exactly what it would be, it must be confessed, is somewhat problematical. The resistance of a train of several cars would be much less per ton of train than that of one car, because of the elimination of some of the velocity resistances of the cars following the first one.

Assuming that we had no grade to help accelerate the trains on starting, and that we increased the speed uniformly for six minutes over a distance of 44,827 feet, the acceleration per second would be .692 feet, while the horse power per car needed to effect this would amount to 1,450.

Our conclusion is that it is an engineering probability that such a road could be built and operated, without departing so radically from present practice as to make the chance of success less than that of failure. In the specific case discussed a careful study and the necessary surveys would lead to many changes and modifications that would tend to reduce not only the maximum power or speed required, but also the cost of construction. This project is no bolder in conception than was the Suez Canal, the Brooklyn Bridge, or the Manchester Ship Canal, so far as the engineering possibilities are concerned. The next paper will treat of probable cost, operating expenses, and receipts.

COST-KEEPING METHODS IN MACHINE-SHOP AND FOUNDRY.

By Henry Roland.

I.—THE ELEMENTS OF COST AND THE INFLUENCE OF WAGE SYSTEMS.

"PRIME cost" means the cost of stock and cost of labor added to all cash expenditures chargeable solely to account of the job or piece under computation.

"Total cost" means the entire cost of the job or piece under consideration, and is composed of the prime cost with a certain addition for its proportion of the "General Expense Account," as it is called in America, or the "Establishment Charges," as it is named in Great Britain.

Cost-keeping, or the ascertaining of prime cost and total cost, is not an indispensable requisite to success in foundry and machine shop management, since many foundries and machine-shops have enjoyed long periods of high repute and great prosperity without the employment of any system of cost-keeping whatever, their managers having had the commercial intuition and ability necessary in order to demand and obtain prices leading to the accumulation of wealth without strictly-formulated business methods.

It is equally true that no elaboration of system will lead a badly-directed shop to success, and many failures have been marked by slavish adherence to those uselessly-attenuated forms of business detail which are the first resort of small executive powers when confronted with large and varied responsibilities. The clear seeing manager is not inclined to load his mind with petty detail, or his office force with a wearying burden of minutely-ramified accounts, but, on the contrary, may wisely and rightly fall back on a method of broad averages, ensuring a tolerable approach to accuracy with a reasonable amount of book-keeping.

There is, however, abundant authority for detailed cost-keeping in the foundry and machine-shop. Books of respectable size have been written on this topic, and to some classes of really capable minds any approach to the uncertainties of guesswork in business details is an annoyance not to be endured, and a manager having a mind of this exact order is almost certain to make extraneous efforts toward exact cost-keeping. It is extremely difficult to reach the exact total cost of any article of manufacture because of the fluctuation of some of the factors which go to make up that cost, and the most careful and painstaking manager may find himself baffled in his attempts to ascertain what is done in his own works, as is shown by the following recital.

In an establishment of world-wide reputation for one class of electrical instruments examples of wonderful uniformity in milled work were shown. Upon being asked the piece-cost of this admirable work the manager directed attention to a young man of much apparent intelligence who stood at one of the milling machines engaged on the work in question with a horse timer in his hand, recording the actual time of operations in progress in fractions of a second. "That young man," said the manager, "is a very bright young technical graduate. I do not know the cost of any single thing made in this place, but, if that young man lives, I shall be able to tell the cost of some things about two years from now—perhaps of a good many things."

Those two years having elapsed, this same establishment was recently visited for information in regard to accurate cost-keeping. The intelligent technical graduate with the horse-timer and fractional second record was a thing of the past, and the manager had no information whatever to give on the subject of accurate cost-keeping, which is much to be regretted, as this manager is not a man to lightly abandon an experiment, nor is he likely to rest short of a close approximation to a desired result; his experience would undoubtedly be of great value, could he be induced to make it public.

But, although the estimating of exact total cost may be very difficult, or even commercially impossible, because of a too great attendant expense in record-making, it is not extremely difficult to closely approximate the total cost of a manufactured article.

The elements of total cost taken in their natural order may be listed as follows,—*viz.*, cost of raw material, and cost of labor, augmented by a certain percentage of the general expense account.

The expense account is inevitable, since a shop must exist before it can take and execute orders for finished product, and hence there are at the outset the three specified principal factors of total cost.

In respect to the cost of material and labor only, there can be no question, and no difference of opinion, generally speaking. The third factor of total cost, the percentage of expense, is open to wide variations, both in determining the elements which shall be held to rightly make up the expense total, and what percentage of that total shall be used as an increment of the stock-and-labor-cost of the manufactured article in question to give its total cost.

As the object of this series of articles is to aid in the reduction of machine-cost by the exhibition of shop methods actually employed by well- and widely-known establishments rather than by advancing and maintaining any theoretical proposition whatever, the discussion of expense-account items will be passed for the present (although the formation of the expense account must in all cases precede the performing of actual work in the shop), and consider the stock-and-labor-cost by themselves, as separated from the total cost.

The first aim of the shop manager or superintendent who is immediately responsible for the cost of the manufactured articles produced is always directed to the reduction of labor-cost, not because labor is always or generally the largest element of total cost, but because the labor-cost is the one element which can be reduced. The expense account is not commonly under the control of the shop superintendent, but is determined by the general policy of the establishment. This policy may involve large advertising and travelling expenses, a credit system which must result at times in collection expenses and losses, and all those other large costs which arise from an aggressive business policy having for its first object the increase of territory covered and volume of transactions consummated.

But, while the policy of the shop may double or treble the total cost of manufactures produced, this policy is not subject to the control of the superintendent, who must therefore direct his attention to the lowering of prime cost by one of two methods,—either lowering the pay of the workmen, or increasing the workmen's output. There is absolutely no other way of reducing prime cost, and, in consequence, there are many different methods of recompensing workmen, each of which is believed best by those using it.

The most obvious form of labor recompense, and the method which actually underlies and governs all other methods, is the day-pay or hour-pay system, which assumes that an hour of the workman's time has a certain value, or "going rate," which may vary considerably for different localities, but is, generally speaking, maintained uniformly in each locality taken by itself, and is also modified in each locality in recognition of individual superiority, this modification, however, never reaching such an extent as to cover the difference in the actual value of the workman's efforts to the shop.

In the old times there were but two classes of "producers," or workmen, in the American machine-shop and foundry,—apprentices and full hands. "Sweepers," "laborers," "skilled laborers," and 'boys" have been added, and now form recognized classes of productive labor, the "boys" taking the place of the old apprentices in many shops, and being passed on into the full-hand list, if they prove bright and trustworthy, or rising no farther than the rank of skilled laborer if they are of the common turn of mind, content with small certainties. By means of this grading the hour-prices of day labor are in many places made to differ very greatly. A boy at 40 cents per day or a skilled laborer at $1.25 per day often attends a machine which under the old order of things might have been managed by a full hand at $2.00 or $2.50 per day, and this brings the hour-price of labor much nearer its actual value to the shop than was possible with the "apprentice" and "full-hand" labor divisions only. But in the hour-rate pay system the workman's actual output is not first considered in fixing his wage. The "going rate" is the standard in all hour-pay decisions. If a hand asks for a raise, he is likely to be told that he is welcome to better himself, but the shop is paying already as much as it can afford, the manager knowing that the workman's hour-pay is up to the going rate, and that he cannot, if he is a mere ordinary hand of his class, obtain more by changing shops.

The final result of the going rate and hour-pay is to fill a shop which is well managed under that system with a working force of steady-going, orderly, well-disciplined men, who produce a moderate output of good work with great uniformity of labor-cost. To increase this output and ensure a certain fixed and unvarying labor-cost of output, the hour-rate of pay may be wholly abandoned, and a plain piece-rate may be substituted.

This piece-rate may be paid to one man for the work of many others under his management, the man who takes the work from the shop becoming a contractor, or the piece-rate may be paid directly to individual workmen in charge of a foreman who is paid a fixed salary.

Piece-work, though nominally ignoring time, and dealing with production only, is always referred to the going hour-rate as a standard, and here two diametrically-opposed practices originate. One practice is based on a theory of increasing floor-area production, or—which is the same thing—decreasing the expense percentage which must be added to the prime cost to obtain the total cost. This practice involves a fixed and unchanging piece-rate, based on the belief that it is more profitable to increase the workman's out-put than to decrease the piece-rate cost of labor. On the other hand, many excellent establishments omit all consideration of area production or large individual machine or individual workman production, and regard the going day-rate as the standard by which piece-rates are to be regulated. In accordance with this view, if a piece-worker is making very much more than the going rate,—that is, very much more than he could obtain elsewhere immediately,—the rate per piece is reduced so as to bring the workman's earnings nearer the going rate. The argument used to the workman to induce cheerful compliance is based on the fact that at the reduced rate he still obtains more for his services than any other shop stands ready to pay him, because he must enter a new shop at the going rate for his class.

Both of these piece-rate policies are pursued with great success, as will be seen later, in the detail of the actual methods employed by individual shops in regulating the labor-cost of their productions.

The rate-fixing policies previously mentioned deal either with time considerations or piece-produced considerations only. There are two other methods of recompensing labor which consider both time and output. The first of these, which has been practised with highly favorable results for many years, makes two different hour-rates to each workman, the greater time-rate being paid if a certain piece-production is reached in a certain time, while the lesser hour-rate is paid if the piece production for the certain time falls below the limit. This difference in hour-rates is based upon the expense percentage which must be added to prime cost, or to the labor-cost, as may be, to produce the actual total cost.

To illustrate this point, which is perhaps not immediately obvious upon first consideration, suppose the addition to labor-cost for expense to be 75 per cent. of the labor-cost, which is much below the average. Suppose also (which is an actual case) that the two hour-rates adopted by the management are 27 and 30 cents, and suppose that a workman is required to make 10 pieces in 10 hours to win the 30-cent rate. Now, if a workman produces 10 pieces in 10 hours and obtains the 30-cent hour-rate, his 10 pieces cost for labor $3.00, and for expense $3.00 × .75 = $2.25, making a combined labor-and-expense-cost per piece of $5.25 ÷ 10 = $0.525 each. If another workman turns out 9 pieces in 10 hours, and obtains $2.70 for his labor, the total labor-and-expense-cost of his 9 pieces is $2.70+$2.70 × .75 = $4.72, making the cost of each one of the nine pieces $4.72 ÷ 9 = $0.5244 +, or, for all practical purposes, the same labor-and expense-cost as that of the piece turned out by the more speedy workman. Hence this double hour-rate may be regarded as equalizing the pay of the workman in this example. Further consideration, however, shows that such is not the case. A given shop has room and tools, a capacity for the economical working of a certain number of men. irrespective of wages paid to each. The expense is a fixed sum, and hence, in case of workmen using the same tools, the expense is more fairly divided by a per man apportionment than by a percentage of the sum of wages paid. In this view of the matter, the workman producing only 9 pieces and earning only $2.70 should have 75 per cent. of $3.00 added to his wages-cost, making a total labor-and-expense-cost of $0.6333 + for each of the 9 pieces, as against $0.525 for the cost per piece of the speedy workman's production.

This simple example is carried out at length under the conviction that this matter of relative individual production of workmen as affecting total cost has not been fully considered by all, or even any large part, of the foundry and machine-shop managers of the United States, at least. It is a common thing to approve a manager who has a shop full of steady-going, medium-priced men, speaking of his management as economical because he does not pay unusual prices or endeavor to "force" his production. But the moment the influence of the expense account is brought to bear on the actual cost of the work produced by these faithful plodders, it is seen that such a labor equipment is of the most extravagant description, and that any system which increased the production would permit the payment of much higher wages while still greatly reducing the total cost.

The attention of foundry and machine-shop managers cannot be too strongly directed to the fact that every square foot of shop-floor must be regarded as an augmenting factor of the expense account, and the best management of workmen is that which produces the greatest output per square foot of floor and per hour of time, and that the maximum effects in these directions cannot be secured with low-priced men whose only aim is to escape discharge and reach pay-day.

The remaining method of labor recompense which recognizes both the lapse of time and the piece-production is known as the "Premium" system, because it is offered to the workman in such form as to appear to place the shop in the position of giving a bonus or premium in the way of a small hour-rate for every hour saved from an estimated time of performance of work. Thus a workman may have a job given him with a time-limit of 15 hours; if he finishes this work in 10 hours, he will also have a "premium" rate of 8 cents per hour paid to him for the five hours saved, making a total of 40 cents added to his regular day-rate for 10 hours. This premium system is a very safe plan for the shop, as will be seen from a detailed example given hereafter. The workman's reward is immediate, and the effect of the premium system in stimulating production is at once apparent in the increased activity and diligence of the operative. If the workman takes the full time-limit, or more than the time-limit, to complete the work, he suffers no penalty. He simply obtains his regular day-rate of pay, losing nothing and gaining nothing; hence he stands in the fortunate position of a possible gainer without risk to himself. Consequently no workman ever objects to the installation of the premium system in the shop where he works, and thus one of the initial objections to the establishment of a piece-rate system in a shop paying hour-rates is obviated. This premium system is commonly used with the understanding that a time-limit once established on a certain piece of work shall not be lowered, which gives the same incentive for exertion as an unchanging piece-rate ; in both cases the workman knows he can exert himself to the utmost without jeopardizing his future rewards. The premium system has an advantage over the fixed piece-rate system in not so greatly increasing the workman's pay if the time-limit is over-estimated as by a too great piece-price estimate, because the premium system recognizes the actual time of performance as the principal factor of the workman's earning. The fixed piece-rate recognizes production only, taking no notice of time; hence, an overestimate of, say, 50 per cent. in the time on piece-prices would result in the piece-worker's doing a day's work in half an day, and thus winning double the wage intended by the management, while, by the premium system, the workman under an over-estimate gains only a comparatively insignificant sum above his regular hour-pay. Hence the premium system is perhaps the easiest and safest of all changes from the hour-pay system.

It is certain that the relations between production and expense are not fully comprehended by all managers directly affected by those relations, and it is also certain that many managers who are vaguely aware that their own management might be improved by the introduction of a production-rate in some form are deterred from a serious consideration of such an adoption by the belief that the work under their charge is so varied as to make the fixing of fair piece-rates impossible. In the examples of actual shop practice which will be submitted in subsequent papers of this series, it will be seen that establishments doing a very considerable variety of work do fix piece-rates upon almost every item of their product. Those managers who have used the piece-rate systems for a long time assert with perfect confidence that there is no difficulty in fixing equitable piece-rates on work of any description, large or small.

It is asserted that the maximum rates of performance of machine tools are easily ascertained, and that, given the length and diameter of a piece of turning or boring, it requires but a moment's calculation to fix upon the very least time in which it can be performed on the tool to be used. So with drilling and planing, shaping, slotting, and milling. Given the thickness of chip to be removed, the number of cuts over, and the dimensions of the surface, any finishing cost can be estimated with perfect certainty, fixed percentages being used for the time of handling work, making ready, cleaning up, and replacing tools.

Undoubtedly to the mechanic who has had no experience in thus estimating work by computation the operation appears extremely complicated and uncertain. Any operative machinist, however, who is accustomed to working against time to make the day pass quickly well knows the very great uniformity of time consumed in repetitions of the same operation, even when large surfaces are to be covered.

After the system of surface-finishing computation is once established in a shop, records accumulate with rapidity, and a rate-fixer with a fair memory speedily acquires such a stock of past performances as to be able to say, off-hand, almost exactly what time will be required to finish a piece of work which is entirely new to him. But there is not the slightest need for guess-work. Every machine tool has its maximum rate, and that rate cannot be exceeded under any circumstances; hence the piece-rate fixer has only to be certain that he adds enough to the least possible time of finishing to cover detrimental conditions to be certain that his estimate will not wrong either the shop or the workman. The efficiency of workmen bears no comparison for uniformity with that of machine tools, and time-limits which might give one workman high day-rates may give only very small pay to another, but in this case justice is done by the employment of the piece-rate; the poor workman obtains poor pay, and, although the shop pays more in all cases for work done by slow men than for work done by fast men, it is not so greatly wronged under the piece-rate as under the day-rate system.

Estimates of piece-cost may be, and often are, made by consultation of experts; this method is used both in small work and large work. There are no facts at hand on which to base any deductions as to the feasibility of making calculation estimates or prices of very-small-dimension work, and the piece-rate fixing on small milling and drilling, and all that class of machine work spoken of as "factory work," is more commonly the result of estimate from past records or from consultation. But it does not seem that any class of work offers any prohibitive difficulties in the way of rate-fixing by computation.

THE INDUSTRIAL AWAKENING OF THE RUSSIAN EMPIRE.

By F. J. Guyon.

ONE of the most significant tendencies of the age is toward the substitution of industrial for political prestige in the rivalry of the great nations. This is preëminently an era of industrial expansion, of the installation of machinery and the development of manufactures, and England, Germany, France, and, more lately, the United States, no longer finding the home markets sufficient for the consumption of the products of their machine-shops and factories or the home developments adequate for the full employment of their educated engineering talent, are turning their eyes toward newer lands, where the natural resources have been less fully exploited, and where there are larger fields, more abundant opportunity, and possibly richer reward for mechanical enterprise, engineering skill, and invested capital.

Under such stimulus the attention of Europe and of America has recently been directed toward Russia; not that Russia lacks excellent engineers and competent industrial managers, but that the country which is to be developed is so enormous that it will be impossible to make her wealth available without outside aid. To quote a recent article in *L'Illustration:* "Her natural resources are immense. Without speaking now of Siberia, whose exploitation will be the work of another generation, the coal-field of Donetz, which measures 25,000 square versts, is one of the largest in the world. The oil wells of Pennsylvania will be exhausted long before those of the Caucasus. In 1895 the Russian production was 400,000,000 pouds,* while that of the United States was but 236,000,000. Russia is literally another America; more ancient, but more recently discovered; newer in a sense, and equally propitious for colossal enterprises. She has her cotton kings, the Marosoff; her Ural kings, the Demidoff and the Stroganoff; and there is room, on this yet virgin soil, for many other kingships of industry and finance."

Concerning a field so important, it may be of value to give some general facts, drawn partly from official documents, due in part to the courtesy of fellow engineers, and in part derived from personal experience extending over a number of years.

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* The Russian poud is about 36 pounds, or about 55½ pouds to the ton of 2,000 pounds.

The production of iron ore is constantly increasing, at the rate of about 10,000,000 pouds a year; so far as concerns the steel and iron made from this ore, however, the output of steel shows an increase of 27 per cent. and that of iron a loss of 2 per cent. per annum. Metallurgical activity turns more and more to the production of steel—an increase which is explained by the orders for the Trans-Siberian and other railways. On the other hand, the iron manufacture seems rather to be neglected, in spite of a fair demand, and a constant rise in price in the different grades is noticeable since 1890. This rise favors importations, and hinders the development of agriculture, to the detriment of the country; for cheap agricultural machinery is much needed.

Rolling of rails has chiefly occupied the Russian steel works, and in recent years their production has been:—

1891—1,650,000 tonnes.*
1892—1,800,000 "
1893—2,300,000 "
1894—2,500,000 "

Since the last date, the advance is still more marked, but is not officially stated.

In the Urals, the Moscow center, Finland, and Volhynia the furnaces run on charcoal. In Poland and South Russia, on the other hand, they use coke. In 1894 the relative production was in the proportion of 7 to 5 in favor of the charcoal iron (42,725,000 pouds, as against 34,536,000 pouds from coke furnaces). Since that time coke has undoubtedly been gaining much more rapidly than charcoal, and the coke production will soon be the larger; the statistics for 1893–94 leave no doubt upon this point. It is noticeable that the output of iron ore is not increasing to any important extent, except in the south, and there the production of iron remains stationary or diminishes, while steel-making is on the increase. Steel-making, on the contrary, is on the decrease in the Urals, and barely holds its own in Russian Poland.

The principal coal-mining centers are the Donetz basin, Poland, and the Urals. Siberia and the Caucasus are also rich in coal, but the bad condition of the roads or their almost complete lack of communication have so far hindered any thorough or extensive exploitation, and the coal production in those districts is unimportant.

The production of the Russian coal mines doubled between 1885 and 1894. Donetz, Poland, the Moscow district, the Urals, Siberia, and the Caucasus together produced 260,580,000 pouds (4,156,000 tonnes) in 1885, and 526,785,000 pouds (8,432,000 tonnes) in 1894. Poland and the Donetz basin especially increased their coal production during this period, French and Belgian capital playing an important part in the development of the mines. On the contrary, the collieries of the Urals and the Moscow district are declining in their production. The inferior quality of their coal unfits them for replacing charcoal, as the forests disappear, and they cannot successfully compete with the excellent Donetz coals.

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* The tonne, or metric ton, is about equal to 1.1 tons of 2,000 pounds.

The fuel of the future seems to be petroleum or its residues, which is more and more used to replace coal in the region of Moscow, and even in many metallurgical works. Oil is so easy and clean to use, requires so little attendant labor, and is so easily regulated, that it seems destined to general adoption as fuel, especially as it gives more heat than coal. Its price, however, is high, and the manufacturers of Moscow have petitioned the minister of finance for a new railroad running to the Donetz field, so that coal may be sent thence at less expense to Moscow. Thus an acute and useful competition may reduce the price of oil throughout the region to a proper level.

Manganese mining is also on the increase, and the same is true of zinc; but copper shows a decline. Neither of the last two metals was produced in sufficient quantity for the demands of the country in 1894, and the importations were 12,000 tonnes of copper and 8,000 tonnes of zinc. The zinc industry is practically confined to Poland, although in the south and in the Caucasus there are important deposits, which no doubt will be developed later. At present, however, the expansion of the Australian and Belgian production has caused so great a decline that the price of sheet zinc has fallen rapidly from 4 k to 2.80 k, actually leaving no profit to the State *concessionaires* and licensees. But, when the Russian works shall have introduced the improved processes which they now lack, and can reduce their manufacturing expenses to the level of the foreign basis, the home industry will have no further fear of the competition of Belgium and Australia, and will easily realize profits of several million roubles yearly. At present but two companies are engaged, and they employ only about 1,400 miners and 700 workmen, in two sheet mills and a zinc-white factory. So far as the Polish production is concerned, the high protective tariff renders Silesian competition almost impossible.

From comparative tables published in the organs devoted to industrial and financial statistics, it appears that the Russian production of petroleum has been continually growing during the last decade, and that in 1895, for the first time, it exceeded the American output. The Russian total, which was but 50,000,000 pouds fifteen years since, reached 400,000,000 pouds in 1895, and one-quarter of this was taken for export. In 1890 Russia produced 243,000,000 pouds, and the United States 355,000,000 ; in 1895 Russia produced 400,000,000, and the United States but 236,000,000. In six years the total Russian output was 1,900,000,000 pouds against only 1,859,000,000 from the United States during the same time. Especially since 1895 has the Russian yield surpassed the American, and entered upon an enormous increase.

Since 1872 the Russian government has abolished the monopoly. Following the year 1894, which had been very unfavorable, the department of railroads sought to favor exportations by two successive reductions of tariff. The situation was deplorable, prices abroad being very low. Indeed, the Americans threw an enormous stock on the market in 1893 ; it was not until the end of 1894 that the reduction of this stock, and the decrease in the American production, checked the decline, since which time an improvement in price has set in.

For some years industrial and engineering attention has been directed toward the south of Russia, and the Donetz basin in particular. Belgians and French have built important iron and steel plants, stamping works and machine-shops, coal and cement companies, glass-works, and other industries. A company has also been organized for the manufacture of explosives and chemical products, near Debaltzeno.

In a word, "Donetz" seems to be the rallying-cry for Russian industrial movements. It must be noted, however, that although there have been built in Russia within the last few years many large establishments for first operations, producing raw materials, there has not yet been erected that most essential complement to large works, the machine-shop capable of making on the spot the tools, repairs, changes, and additions which such work constantly requires.

The Ural district, being rich in minerals and especially in iron, has long had important works on both slopes. The principal industry in these establishments is the rolling of thin sheet-iron, measuring about .71 × 1.42 meters and about ½ millimeter thick. These sheets are in extensive use in Russia for roofing, being laid flat (after turning over the edges with a wooden mallet) and painted green or red. Iron in heavy sheet is also manufactured in these works, but in small proportion. Thus, out of a production of 20,000 tonnes of iron at Alapaepk, 15,000 were thin sheet, the remaining 5,000 representing plate and heavy sheet.

The works on the European slope, having mineral coal at their doors at lower cost than charcoal, use it in preference. The establishments of the Asiatic slope, on the other hand, employ charcoal exclusively for blast furnaces, puddling furnaces, and forges. The iron which they produce is therefore of better quality, but more expensive. It could not be otherwise, since some of these works must bring all the wood, or charcoal, needed in the works a distance of fifty kilometers by special railway. Another cause of the advanced price is found in the amount of ready capital needed, which is necessarily great, for the wares are sold at the Nijni Novgorod fair, held but once a year.

Besides iron, the Neuianski works heat gold ores, and the Bogokowski works ores of copper. The latter also manufacture sulphuric acid and phosphorus, operate a glass works and a cement manufactory, and are installing a model plant for rolling steel rails.

All these manufactures depend on wood for fuel. The species of trees most abundant are firs and beeches. There are also lindens and aspens, but the commonest tree is the fir.

The Ural region is rich also in precious stones of all sorts—topaz, amethyst, chrysolite, garnet, emerald, aqua-marine,—indeed, all except the diamond.

It is in the industries dependent upon railways that progress in Russia is most needed. The Russian empire needs 10,000 locomotives and several hundred thousand railway wagons. Equipment is deficient at many points, and the crops suffer for lack of transportation facilities. Metallurgical works also are at times stopped by total exhaustion of their supply of fuel, which can not be replenished in time, owing to lack of necessary rolling-stock.

A single American company has taken an order for several hundred locomotives, of which one hundred are to be delivered in the shortest possible time. This order has involved the construction, on the banks of the Volga, of a shop employing 5,000 workmen.

Another establishment, of French origin but organized under a Russian name, has taken an order of equal importance for rolling-stock, and will keep many workmen busy for several years. The world will follow with intense interest the Russian industrial movement, which will be greatly accentuated upon the completion of the Trans Siberian railway. This road will open to industry and commerce an enormous country whose richness, although well recognized, has so far remained undeveloped for lack of means of communication.

In the great competitive struggle now opening in Russia, a struggle between the genius and the methods of two continents and many nations, it will be most interesting to observe the victories. Ere long we can judge who have best succeeded in introducing their national industries into this new land whose needs are as vast as its territory.

There are likely to be two classes among the industrial immigrants,

—those who find a closed door, and those within, who have themselves closed the door to their rivals.

But this suggestion would be incomplete without directing attention to some suggestive remarks which conclude the article in *L'Illustration*, from which quotation has already been made. M. Normand, after reviewing the comparatively large extent to which French capital, usually most timid, has been embarked in Russian enterprise, adds: "Thus, what we scarcely do in our own distant possessions, we have begun to do in Russia. We are planting there colonies of engineers, of chemists, of skilled workmen, . . . and of capitalists. It is much to be hoped that this movement will be accelerated. If the Russian empire affords no market for our merchandise, which cannot there find a *clientèle*, it will at least extend warm welcome to the too-often-idle capital, the too-little-used energy, which abound in our land.

"Against importations from Germany and England, and in default of importations from France, French production, planted on Russian soil by the aid and for the profit of French capital, will at least contend with advantage. . . . French industry will be in its proper *rôle* when it aids industrial Russia in the struggle against an outside competition, in which French commerce has no part."

Without entering upon a politico-economical discussion, we may share M. Normand's vision of the splendid opportunities which Russia is opening for the exercise of the talents of the engineer, through the whole range of his profession, and for the introduction of the engines, the electrical machinery, and preëminently the machine-tools which represent the crystallized thought of the mechanician. "There is room, on her yet virgin soil, for many kingships of industry and finance."

EXPLORING AND EXPLOITING A GOLD COUNTRY.

By Albert Williams, Jr.

AFTER every new discovery of mineral which happens to be of sufficient importance to attract attention from the outside world, there follows in train, as a sort of logical sequence, a certain series of occurrences. To any one who has been on the spot at the time of a strike and its following rush and excitement, it is easy to foretell what would happen in a similar contingency. History never repeats itself so surely as in these stories of mining. At Wood River, at Creede, at Cripple Creek, to say nothing of the countless rushes of early California and Nevada times, it was just the same. First comes an account of a big strike, magnified by the rose-colored lenses of the prospector. No matter how honest a man, if he once happens to light on a good find it is sure to grow multifold in his sight.

After the first news of such a strike, a number of enterprising prospectors start out for the locality, hoping to find something equally good. With them go some people of the sutler class who propose establishing shops,—general merchandise stores, they are called. This movement is, of course, reported in the papers, and attracts the attention of a larger crowd of persons, who might be called enterprising, but are mainly shiftless. This is the beginning of the rush proper. The next move is by transportation and supply companies, who do not hesitate to exaggerate the reports from the new districts, and, in the cases of Creede and Cripple Creek, owning also the newspapers, kept on lying long after there was any hope or chance for the tenderfoot incomers. For it does not take long for all the ground that is at all promising to be "located," and often covered with thousands on thousands of claims, many of them overlapping and conflicting, out of the whole number only a very small proportion ever amounting to anything. It is only natural to expect that the early comers should select the best ground; in some cases the original discoverers have taken everything worth having. This would apply, however, to a district of limited size, as, for example, the Bonanza and El Dorado Creek portions of the Klondike region, rather than the wider and more varied area of possibly mineral-bearing ground included in the whole newly-discovered placer country.

In these big mining rushes the later comers usually fare very badly. To obtain some idea of what the proportion of disappointments generally is, it should be remembered that at both Virginia City and Leadville there were more than one hundred thousand persons at one time, while at Creede and Cripple Creek, which happened to be more easily accessible, men came and went in such numbers that there was no way of estimating their total number. The rushes to Boise Basin (Idaho) and the Black Hills (South Dakota) involved great hardship, hardly, if any, less than the present Alaska movement, to which was superadded the danger from hostile Indians; yet the prospectors, the traders, and the camp-followers poured in by thousands. It is worth considering how very few out of all these thousands ever acquired real mining ground, or even employment. In every case on record there have been from ten to a thousand unsuccessful ones to each who succeeded. It was so in the early days of California, where all the conditions were ideally favorable; but in California and other places more favored by nature than Alaska there was room for the disappointed ones to do other things than mine. In the latitude of the Arctic circle, and inland, there is little else to look for than mining and the few industries depending upon it,—transportation, timber-cutting, etc.

Now, as to the Klondike country this same thing is being repeated. Besides the usual small games, and the larger ones of transportation and the sale of outfits and provisions, we find another usual accompaniment—speculation; just as, after the wealth of the Rand became known, London was flooded with promoters and corporations offering shares, so now we see the Klondike opportunities being seized upon. In a reputable paper now before me I find a column and a half of advertisements of Yukon and Klondike and Alaska corporations, in none of which appears the name of a mining man of whom anybody has ever heard. The most reasonable scheme proposed is that of establishing a line of steamboats and going into trading business in anticipation of next year's promised rush. That project will be forestalled by the exertion of the shrewd ship-owners of Seattle, Tacoma, San Francisco, and Victoria, whose light-draft boats are now building, and will be ready when the season opens.

Another beautiful plan advertised is the tempting proposal of some very new women to "man" a schooner yacht, sail around the Horn, and arrive in Alaska some time in futurity.

But among all these advertisements I find none so open to criticism as the proposition "to acquire and operate mining claims;" and this is what nearly all of them point to.

Those who would never think of going into the collar-button and necktie business, and are willing to confess their ignorance of the technical details of that trade, are still willing to stake their money in mines. They seem to regard the business as a sort of lottery, in which the chambermaid has an equal chance with the financier.

It always seems foolish to attempt predictions about new mining fields which one has not even visited. Yet in this case there are some things which can be safely said. There are several mining experts in the Klondike country who will have to winter there, and will have from now until next June to look at the ground. They will find, for one thing, that there is no particular Klondike; that the discoveries are in many separate camps; and that the whole territory about which we get these almost fabulous reports is a very big one.

So there is no one special point to look for. In fact, any explorer would be bothered by the multiplicity of richness, in the same sense that a prospector in Montana, Idaho, or Colorado is perplexed by finding colors in any pan from any creek. Finding traces of fine gold proves nothing in a country where there are innumerable quartz veins of no value, but which contribute their float to mislead the prospector.

So far, what gold has been taken out in the upper Yukon country has come from shallow placers, running from ten to twenty feet deep, with the best pay, as usual, on the bed rock. In the short season there has been some hydraulicing, but most of the "get" has been by more primitive means.

From all one can learn, it will not take long to work out the rich, shallow placer-ground in any one locality. Afterward there will be a period of quartz-mining. Whether the upper Yukon country is destined to rival Nevada county, California, or Gilpin county, Colorado, or the Transvaal Rand, is something no one knows. Supposing it to be equal, as regards the mineral conditions, nevertheless the climate and the distance from supplying points are adverse. So far as the actual mining goes, when it comes to underground work climate does not count. Where it tells is in the matter of transportation.

If the mining men now in the Yukon country are wise, they will cease looking for phenomenally rich streaks in small placers, and will search for the original quartz veins from which these placers have been made. The gold of the Klondike and Stewart river countries is coarse, indicating a short journey from its original source. It was to have been expected that some important discoveries of lodes would be made before now, but it seems that all attention has been paid to the placers. As to these finds in river beds, they have very likely been equalled by those in Boise Basin, in California Gulch, and in many other places, the difference mainly being in the coarseness of the Yukon gold. This coarseness seems to have put a queer idea into the illustrators of *Puck*, which for two weeks printed pictures of supposed gold pans with gratings in their bottoms, the scheme evidently being, to the artist's mind, to screen out the small gravel and mud, retaining only the big nuggets.

But we must not look disdainfully on the gold pan. It, or some similar appliance for testing by washing, is the only available means for estimating the value of gravel, which of course it would be absurd to assay. Although its work looks so rough, in reality, in experienced hands, it gives wonderfully accurate results, so that it is not only used with gravel, but is by many considered far better than the fire-assay for gold-bearing quartz, when the ore is pounded up, screened and washed in it. Formerly it was used wholly for getting gold; now it is used for testing and for cleaning up small lots of particularly rich stuff. It is the implement with which the future exploration of the Alaska gold fields will be effected.

Theoretically everyone knows by this time the art of exploring and exploiting a gold country. It has been so well acquired that a handful of men can overrun a wide territory in a few days, and locate all the placer-ground worth taking up. The idea, for quartz, is simply to follow up the gulches and cañons wherever the pan shows the color; to stop when the indications cease or lessen; and then to skirmish in the side or end hills for a lode. All of which looks easy on paper. In practice, however, if one is prospecting in a "mineral" region, colors are found everywhere. Then it is necessary to use the pan, not as a mere means of finding gold, but as a means of estimating how much,—that is, it becomes an assay, though closer than any assay.

After experimenting with the horn spoon, saucers, Riotte spoon, the batea, pointed tumblers, and all sorts of appliances, it is my opinion that there is nothing to compare with the old, original, California 20-inch gold pan, stamped out of one piece of sheet iron, with an angle of, say, 30° and no crease in the bend. With this tool, and a five-minute instruction, but with considerable experience, one can rapidly reach a rough estimate of the value per ton in gravel or pounded rock. That is something which the fire-assay cannot do for the prospector.

It is a great convenience to have two gold pans or else one pan and a bucket, so as to save time. In this way the rough work can be done rapidly, the small stuff containing the gold being thrown together into the other receptacle, the prospector keeping in his mind a tally of the number of pans. A heaped pan-load weighs about twenty pounds, so that one pan represents the hundredth part of a short ton. It is easy to acquire the habit of picking up uniform pan-loads. With gravel, the amount of the pan-load depends somewhat on the size of the stuff, all moderate-sized pebbles being washed and allowance being made for boulders, which requires judgment. In testing pounded quartz, the most convenient weight is ten pounds, or the two-hundredth of a ton. A larger weight of gravel can be used,—fifteen to twenty pounds. The knack of gaging the quantity is easily acquired, all that is necessary being to determine on some convenient aliquot part of the ton or cubic yard, the latter ranging between one and one-half and one and three-quarter tons, so that a pan will stand for the 100th, 150th, 200th, or other fraction, with allowance for boulders. When using two pans, after taking enough samples, all the small lots of concentrates in the second pan are together washed carefully over the first pan, the overflow tailings rewashed, and the aggregate result carefully cleaned by drying, removing black sand by a magnet and winnowing off the rest of the waste. When the amount of gold collected is considerable, it is weighed in the most delicate balance available. Estimating "colors" is a different matter, as a small fraction of a cent makes a showing to mislead the novice. With a little practice and advice from an old hand, this art also is mastered.

It is by means of this sort that the Yukon country will be prospected and developed. At present it is going through the stages that early California went through. The rocker, the tom, and the short sluice are there. Hydraulicing and booming have, so far, been conducted only on a small scale, and, as the open season is so short and the gravel so shallow, this kind of mining cannot last long. The future is in the quartz.

Perhaps the best way to "size up" a "rush" is to remember what has happened in others. About once in three years an excitement of this kind occurs in the mining community. That it extends now to the outside public is due to greater newspaper advertising.

It has always happened that, after a great mining excitement and its accompaning speculative fever, there has been a sharp reaction, often a crash and a temporary set-back, with a slow recovery. Afterwards a district that has been over-boomed, and then underrated, settles down to its normal level in the opinion of investors, and work goes on less feverishly and more successfully. Some of the mining corporations which will be engaged in really exploiting the new Yukon mines will doubtless pass through the same experience. As for the catchpenny schemes, the sooner they are exploded the better for Alaska. But there is little doubt of there being real and substantial merit somewhere in all that vast new area, or areas, so that it is passible that there may be worthy rivals of the great Treadwell, so far Alaska's single heavy gold producer.

If there are such mines in the far north, it will require extraordinary effort to get in machinery and supplies, and to put them in shape for active production. Little, comparatively speaking, is needed to outfit a small placer,—sometimes only the crudest appliances, such as some lumber whip-sawed or turned out by a small saw mill on the spot, supplemented by a nozzle or two and a few hundred feet of canvas pipe. But to equip a big hydraulic mine, supposing there to be warrant in the ground for putting in an extensive plant, involves heavy expense for transporting the miles of large steel or iron piping and other metal fixtures required.

Supposing that the prospecting for the quartz lodes, from which the placers already discovered were derived, should reveal something in the nature of a big mine, or mines, it is not a necessary sequence from the richness of the gravel that the veins should be small and high-grade ones, for which moderate plants would suffice, involving even in this case freight charges amounting to several times the cost of the machinery at the foundry. The famous gold quartz mines of the world have been, and are, of moderate down to very low-grade ore. In fact, the most productive have been of extremely low-grade, but having large deposits. So, judging from analogy, if really great quartz mines are to be found and properly developed in the new regions, we shall see some achievements in rapid equipment and overcoming of disadvantages which will almost put the celebrated work on the Homestake (Black Hills) mine to the blush. In the last mentioned case a railroad—engine, rails, and all—was hauled in by wagon teams hundreds of miles from the nearest railroad. A modern plant for a big gold mine is something to look at with respect, with its heavy hoisting, haulage and pumping equipment, its huge mills containing hundreds of stamps, and its constant heavy renewals and supplies. Low-grade mines have to be worked on a very large scale to render a profit. So, if there are to be new Homestakes or Treadwells up the Yukon, there will be some nice engineering that is not mining.

It is a great pity that, no matter how successful the new districts turn out to be, provided they are successful at all, the public will have lost interest, and the newspapers will not devote space to describing the most interesting part of the work. Next season it will be an old story. But, if the work this fall, winter and spring reveals a small fraction of what the shouters promise, there will be some hustling in Alaska, though the general public will hear little of it.

PROGRESS IN THE PERFECTION OF THE RACK RAILWAY.

By E. L. Corthell.

COMPARATIVELY few persons, perhaps, realize the importance which the rack railway has attained, not only as a highly-perfected engineering construction, but as an effective economic development. That which, barely a quarter of a century ago, was regarded as a curiosity of engineering, ingenious rather than practical in its tendencies, has made quiet, but steady, progress in perfection and application, until it commands general respect, not merely for the financial interests directly involved, but for its value as a factor in transportation problems and in the development of hitherto difficultly accessible regions.

Seventy seven of these railways, some for passengers alone and some for commercial purposes, carrying passengers and freight, have been put into operation in different countries of the world. It is an appropriate time to review the history of this development, especially as a rack railway is now projected which surpasses all others in boldness of conception.

It is not generally known by visitors to Lucerne, Switzerland, that living and working quietly at his home in the center of that city is the engineer whose name is seen on rack locomotives all over Christendom,—the designer and builder of the "Système Abt," Monsieur Roman Abt, one of the most accomplished civil engineers in Europe. The travelling world is indebted to him for overcoming, for purposes of transportation, some of the most serious physical obstacles to access to the most impressive viewpoints in the mountains. The writer has thought it no more than just to Mr. Abt, and of sufficient interest to the readers of THE ENGINEERING MAGAZINE, to so analyze the history of rack railways as to place by themselves the twenty-nine roads built by Mr. Abt or under his general direction.

The advantages of the combined rack and adhesion system will be stated, in the hope that this method may consequently be applied in many cases where railway managers are now undecided how to surmount great elevations for commercial purposes, like those from the low-lying Tierras Calientes of Mexico to the table-lands, from 8,000 to 10,000 feet above the level of the sea. Then will be described the great tourist road, now in the initial stages of construction, to surmount the Eiger, Mönch, and lofty Jungfrau, in the mountains of Switzerland.

History has repeated itself in the rack railway, and yet the history of the steam railway lies entirely within the limits of the nineteenth century. So marvelous, however, have been the rapidly-progressive developments, and so important results have come, and are still coming, from the comparatively recent developments of electric traction, that it appears to be centuries since Trevethick astonished the people of London by appearing on the streets with a road locomotive. The next year (1804) a locomotive of his design hauled a coal train up an incline in South Wales. This locomotive ran on iron rails, but, notwithstanding his great inventive genius and original ideas, he made a mistake that retarded the development of the railway until Bracket discarded the erroneous idea in 1814. Trevethick, and other engineers as well, believed that the wheels would slip on the rails, if protruding nails were not driven in that part of the tread of the wheel that overhung the rails, to indent themselves into a wooden exterior surface. They believed that smooth wheels on rails apparently smooth would not produce sufficient friction to overcome the force of gravity of the train-load on even moderate grades. For this reason Blenkinsop, in 1811, built, near Leeds, a real rack-bar railroad. But it did not work satisfactorily. Bracket then made a practical experiment to prove the efficiency of adhesion-friction. Following him came George Stevenson, who built the first engine to produce traction by adhesion. In spite of the incredulity of people, he, with his "iron horse," in 1819, hauled trains of coal-cars at a speed of four miles per hour. From this grew the great adhesion systems of the world, now employing nearly eighty thousand locomotives. The time came, however, when the adhesion principle reached its useful, and even practicable, limit in surmounting steep grades. The friction of the driving-wheels on the rails became less than the sum of the resistances required to haul the train. It became evident that we must either turn the mountains into plains,—an impossible task,—or else build a motor that would not depend on its weight to overcome steep inclines.

Thus, after a little more than half a century, we came back to Trevethick and Blenkinsop. But it was not in old, but in New, England, that the mountains were first scaled by a rack railroad. Sylvester Marsh, in 1861, attempted to prove the practicability of reaching the top of Mount Washington, New Hampshire, 6,268 feet above the level of the sea. But it was with the greatest difficulty that money could be found for such an untried experiment; so that it was not until 1869 that he completed this work and began to take people to the mountain-top. His success made it possible for Riggenbach, of Switzerland, to raise his money, and soon the Rigi-kulm was reached by a similar railroad. As a matter of considerable historic interest, and to show by contrast the

INDEX NUMBER	ROAD	COUNTRY	SYSTEM	DATE BUILT	ELEVATION ABOVE SEA LEVEL				GAUGE		LENGTH				MAXIMUM GRADIENT per cent		NATURE OF TRAFFIC (see foot-note)	MAXIMUM TRAIN LOAD metric tonnes
					LOWEST		HIGHEST				RACK		TOTAL					
					FEET	METERS	FEET	METERS	FEET	MILLIMETERS	MILES	KILOMETERS	MILES	KILOMETERS	ADHESION	RACK		
1	Middleton-Coal Mines	England	Blenkinsop	1812					4'-8½"	1435	3.5	5.6	3.5	5.6	—	6.6	F	85
2	Madison-Indianapolis	United States	Cathcart	1847					4'-8½"	1435	1.3	2.1	2.0	3.2	2.1	6.0	P+F	170
3	Mt Washington	" "	Marsh	1868	1682	512.7	6268	1910.4	4'-8½"	1435	2.8	4.5	2.8	4.5	—	37.1	P	7
4	Rigi-Vitznau	Switzerland	Riggenbach	1871	1440	438.9	5741	1750.0	4'-8½"	1435	4.3	7.0	4.3	7.0	—	25.0	P	10
5	Ostermundigen	"	"	1871					4'-8½"	1435	0.4	0.6	1.0	1.5	0.5	10.0	F	30
6	Kahlenberg	Austria	"	1874			1588	484.0	4'-8½"	1435	3.4	5.4	3.4	5.4	—	10.0	P	40
7	Schwabbenberg	Hungary	"	1874			1290	392.0	4'-8½"	1435	1.9	3.0	1.9	3.0	—	10.2	P	35
8	Arth-Rigi	Switzerland	"	1875	1378		5741	1750.0	4'-8½"	1435	6.1	9.8	6.1	9.8	—	20.0	P	13
9	Rorschach-Heiden	"	"	1875	1312		2572	784.0	4'-8½"	1435	3.4	5.5	4.3	7.0	1.0	9.0	P+F	35
10	Wasseralfingen	Württemberg	"	1876					3'-3⅜"	1000	0.5	0.8	1.9	3.0	2.5	7.6	F	25
11	Rüti	Switzerland	"	1877					4'-8½"	1435	0.1	0.1	0.4	0.6	1.4	10.0	F	18
12	Laufen	"	"	1878					4'-8½"	1435	0.1	0.1	0.2	0.3	0.5	5.0	F	18
13	Friedrichsegen	Germany	"	1880					3'-3⅜"	1000	0.4	0.6	1.5	2.4	3.0	10.0	F	10
14	Sálgo-Tarjan	Hungary	Leiterstange	1881					2'-7⅛"	790	2.5	4.0	5.6	9.0	2.5	10.7	F	18
15	Herdorf-Copper Mines	Germany	"	1882					2'-9½"	850	0.1	0.2	1.5	2.4	2.8	9.0	F	20
16	Petropolis	Brazil	Riggenbach	1882					3'-3⅜"	1000	3.7	5.9	3.7	5.9	—	15.0	P+F	20
17	Green Mountains	United States	Marsh	1883					4'-8½"	1435	2.3	3.7	2.3	3.7	—	30.0	P	7
18	Drachenfels	Germany	Riggenbach	1883					3'-3⅜"	1000	0.9	1.5	0.9	1.5	—	20.0	P	13
19	Corcorado	Brazil	"	1883					3'-3⅜"	1000	2.3	3.7	2.3	3.7	—	30.0	P	8
20	Rüdesheim	Germany	"	1884					3'-3⅜"	1000	1.5	2.4	1.5	2.4	—	20.0	P	14
21	Degerloch	Württemberg	"	1885					3'-3⅜"	1000	1.2	2.0	1.2	2.0	—	17.2	P	15
22	Zakarotz	Hungary	"	1885					3'-3⅜"	1000	2.6	4.2	3.4	5.5	2.0	10.0	F	18
23	Assmannshausen	Germany	"	1885					3'-3⅜"	1000	0.9	1.4	0.9	1.4	—	20.0	P	14
24	Naples	Italy	"	1886					4'-8½"	1435	0.5	0.8	0.9	1.5	2.0	7.0	P	23
25	Langres	France	"	1887					3'-3⅜"	1000	0.6	1.0	0.9	1.5	3.0	17.2	P+F	15
26	Gaisberg	Austria	"	1887					3'-3⅜"	1000	3.3	5.3	3.3	5.3	—	25.0	P	9
27	Pilatus	Switzerland	Locher	1888	1447	441.0	6791	2069.0	2'-7½"	800	2.9	4.6	2.9	4.6	—	48.0	P	3
28	Brunig	"	Leiterstange	1888	1867	569.0	3094	1004.0	3'-3⅜"	1000	5.6	9.0	10.0	16.0	2.5	12.0	P+F	35
29	Hollenthal	Baden	Bissinger	1888					4'-8½"	1435	4.5	7.2	28.7	35.0	2.5	5.6	P+F	90
30	Padang	Sumatra	Riggenbach	1889	472	143.9	7000	2133.0	3'-6"	1067	18.0	29.0	32.9	53.0	2.3	8.0	P+F	60
31	Petersberg	Germany	"	1889					3'-3⅜"	1000	0.7	1.2	0.7	1.2	—	28.0	P	9
32	Achensee	Austria	"	1889					3'-3⅜"	1000	2.0	3.5	3.9	6.3	2.5	16.0	P+F	16
33	Berner Oberland	Switzerland	Leiterstange	1890	1871	570.3	3404	1037.6	3'-3⅜"	1000	2.7	4.4	14.5	23.4	2.5	12.0	P+F	40
34	St Gallen-Gais	"	Klose	1890			3015	919.0	3'-3⅜"	1000	2.0	3.3	8.7	14.3	4.0	9.2	P+F	60
35	Oporto	Portugal	Riggenbach	1891					5'-5¾"	1670	0.4	0.7	0.6	1.0	—	12.5	P+F	40
36	Neuenburg	Switzerland	Leiterstange	1892					3'-3⅜"	1000	0.4	0.6	1.1	1.7	2.4	7.5	P+F	18
37	Honau-Lichtenstein	Württemberg	Klose	1892					4'-8½"	1435	1.4	2.2	21.7	35.0	2.2	10.0	P+F	100
38	Madeira	Madeira	Riggenbach	1892					3'-3⅜"	1000	2.0	3.2	2.0	3.2	—	25.0	P	9
39	Valombrosa	Italy	Telfener	1892					2'-7½"	800	2.8	4.5	2.8	4.5	—	22.0	P	9
40	Barmen	Germany	Riggenbach	1893					3'-3⅜"	1000	1.0	1.6	1.0	1.6	—	18.5	P	12
41	Sulmona	Italy	Leiterstange	1893					4'-8½"	1435	2.8	4.5	7.4	12.0	3.5	10.0	F	35
42	Wengernalp	Switzerland	"	1893	2621	799.0	6772	2064.0	2'-7½"	800	11.2	18.0	11.2	18.0	—	25.0	P	9
43	Schynige Platte	"	"	1893	1927	587.3	6464	1970.0	2'-7½"	800	4.5	7.3	4.5	7.3	—	25.0	P	9
44	Monte Carlo	Monaco	Riggenbach	1893					3'-3⅜"	1000	1.6	2.5	1.6	2.5	—	25.0	P	9
45	Sumatra	Sumatra	"	1893	—	—	—		3'-3⅜"	1000			18.6	30.0		12.0		
46	[illegible]	Germany	"	1893					3'-3⅜"	1000			2.1	3.3		25.0	P	
47	Chamonix-Mer de Glace	France	"	[illegible]	3445	1050.0	6398	1950.0			1.7	2.7	3.4	5.5			P	
48	Jungfrau	Switzerland	Strub	-	6765	[illegible]	[illegible]	[illegible]	3'-3⅜"	1000	9.5	12.3	9.5	12.3	—	25.0	P	

Note. In the next to last column above, "P" = Passengers only. "P+F" = Passengers and Freight and "F" = Freight only.

TABLE I. SUMMARY OF RACK RAILWAYS. RIGGENBACH AND OTHER SYSTEMS.

INDEX NUMBER	ROAD	COUNTRY	DATE BUILT	ELEVATION ABOVE SEA LEVEL				GAUGE		LENGTH				[illegible]		[illegible]	[illegible]
				LOWEST		HIGHEST				RACK		TOTAL					
				FEET	METERS	FEET	METERS	FEET	MILLIMETERS	MILES	KILOMETERS	MILES	KILOMETERS	[illegible]	[illegible]		
1	Harz Railway	Germany	1885	650	198.2	1652	503.5	4'-8½"	1435	4.7	7.5	19.0	30.5	[illegible]	[illegible]	P+F	135
2	Lehesten	"	1885					4'-8½"	1435	0.8	1.3	1.7	2.7	3.5	8.0	F	50
3	Oertelsbruch	"	1885	1834	559.0	2111	643.4	2'-3⅛"	690	0.4	0.7	3.1	5.0	5	13.1	F	7
4	Puerto Plato	Venezuela	1886	1512	460.8	2256	687.6	3'-6"	1067	2.4	3.8	2.4	3.8	–	[illegible]	P+F	60
5	Mt Generoso	Switzerland	1890	905	276.0	5237	1596.1	2'-7½"	800	5.6	9.0	5.6	9.0	–	22.0	P	[illegible]
6	Visp-Zermatt	"	1890	2144	653.6	5281	1609.0	3'-3⅜"	1000	4.7	7.5	21.7	35.0	2.5	12.5	P+F	45
7	Manitou-Pike's Peak	United States	1890	6604	2013.0	14196	4327.0	4'-8½"	1435	9.3	15.0	9.3	15.0	–	25.0	P	18
8	Eisenerz-Vordernberg	Austria	1890	2268	691.2	3950	1204.7	4'-8½"	1435	9.0	14.5	12.4	20.0	2.5	7.1	P+F	120
9	Transandine	Chile	not completed	5052	1540.0	10860	3310.0	3'-3⅜"	1000	17.4	28.0	46.5	75.0	2.5	8.0	P+F	60
10	Sarajero-Konjica	Austria	1890	787	240.0	2887	880.0	2'-6"	760	12.4	20.0	34.7	56.0	1.5	6.0	P+F	75
11	Diakophto	Greece	1891	33	10.0	2343	714.1	2'-5½"	750	2.2	3.6	14.3	23.0	3.5	14.5	P+F	16
12	Rothhorn	Switzerland	1891	1889	575.9	7448	2270.0	2'-7½"	800	4.9	8.0	4.9	8.0	–	25.0	P	9
13	Glion-Naye	"	1891	2257	688.0	6240	1902.0	2'-7½"	800	4.9	8.0	4.9	8.0	–	22.0	P	10
14	San Domingo	West Indies	1891	33	10.0	2133	650.0	2'-6⅛"	765	4.0	6.4	22.4	36.0	4.0	9.0	P+F	50
15	Mt. Salève	France	1891	1339	408.0	3747	1142.0	3'-3⅜"	1000	5.6	9.0	5.6	9.0	–	25.0	P	10
16	Usui-Toge	Japan	1892	1275	388.6	3080	938.8	3'-6"	1067	5.3	8.5	6.8	11.0	2.5	6.7	P+F	100
17	Revard	France	1892	866	264.0	4958	1511.0	3'-3⅜"	1000	5.7	9.2	5.7	9.2	–	21.0	P	10
18	Montserrat	Spain	1892	460	140.1	2349	712.4	3'-3⅜"	1000	4.9	8.0	4.9	8.0	–	15.0	P	20
19	Schafberg	Austria	1893	1650	503.0	5691	1734.6	3'-3⅜"	1000	3.7	6.0	3.7	6.0	–	25.5	P	9
20	Beyrut-Damascus	Syria	1894					3'-5"	1050	19.8	32.0	86.8	140.0	2.5	7.0	P+F	100
21	Travnik-Bugojno	Austria	1894	2017	614.8	2546	775.9	2'-6"	760	3.9	6.3	26.0	42.0	1.5	4.5	P+F	120
22	Salgo-Tarjan	Hungary	1895					2'-1"	635	0.1	0.2	2.0	3.2	3.5	14.0	F	12
23	Snowdon	England	1895					2'-7½"	800	4.5	7.3	4.5	7.3	–	18.3	P	16
24	Tiszolez-Zolyom	Hungary	1895	1437	438.0	2384	726.5	4'-8½"	1435	3.7	6.0	26.0	42.0	2.2	5.0	P+F	175
25	Schneeberg	Austria	1896	1890	576.0	5876	1791.0	3'-3⅜"	1000	6.2	10.0	6.2	10.0	–	20.0	P	15
26	Gornergrat	Switzerland	1897	5305	1617.0	9902	3018.0	3'-3⅜"	1000	6.2	10.0	6.2	10.0	–	20.0	P	14
27	Hernadthal	Hungary	1896	1221	372.0	1240	378.0	4'-8½"	1435	0.2	0.3	0.8	1.3	2.0	10.0	P+F	32
28	Peñoles Silver Mines	Mexico	1897	1870	570.0	3166	965.0	2'-6"	760	1.9	3.0	6.2	10.0	3.0	15.0	F	15
29	Mt. Lyell	Australia	1896					3'-6"	1067	4.7	7.6	14.4	23.3	2.1	6.3	P+F	50

Note:- In the next to last column, above, "P"=Passengers only; "P+F"= Passengers and Freight; and "F"= Freight only.

TABLE 2. SUMMARY OF RACK RAILWAYS. ABT SYSTEM.

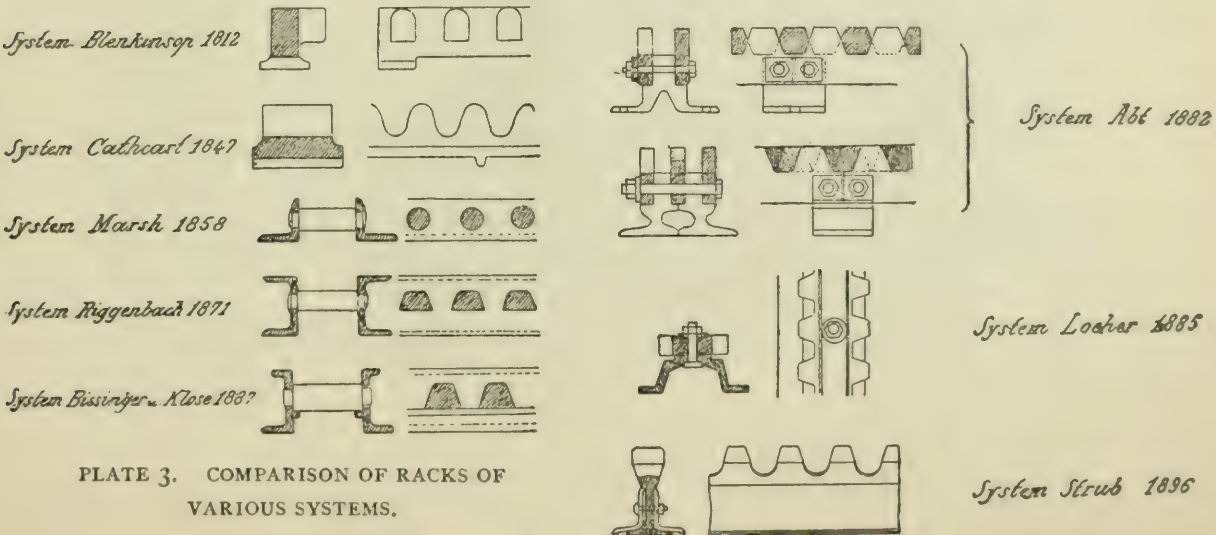

PLATE 3. COMPARISON OF RACKS OF VARIOUS SYSTEMS.

development of the rack railroad, a brief account of this Mount Washington road will be given.

In 1857 Marsh applied to the State legislature for a charter, but the project was regarded as the dream of a madman, and it was only after repeated applications that he obtained the charter. It is on record that a member of the legislature said: "Do not let us waste time in this discussion. If the man wishes a charter to build a railway to the moon, let us give it to him." The style of this first rack is seen in the comparative sketch of various systems (Plate 3). The early engines had vertical boilers, 10 feet high and 4 feet in diameter, with the old petticoat form of smokestack. The weight of the engine was six tons, and, working under normal conditions, it was able to push six tons of load to a height of 3,586 feet above the starting-point.

Compare this picture with that of the recently-built Abt locomotive, weighing 80 tons, for the Hungarian railway now under construction (Plate 8).

The late Mr. W. W. Evans stated in 1874, in forwarding a paper by the late Mr. Otto Gruninger, describing the Mount Washington railway: "I have had it translated (from the German manuscript) so that I could send it to the Institution of Civil Engineers, to be put on record there for the benefit of the members interested in mountain railways, and as a proof that Mr. Sylvester Marsh was the inventor of all the chief features of this system, and not Mr. Riggenbach. In claiming for Mr. Marsh the invention of the chief features (except the rack rail and cog wheels, which belong to Blenkinsop of many years ago), I mean its application to very steep gradients, the air brake, the type of locomotive used, and much of the detail of engines, cars, and track, as now copied and used on the Rigi railway. They belong to Mr. Marsh." The secretary of the Institution appends a foot-note to the abstract (published in 1888) of the original paper of M. Gruninger, as follows:

"The foregoing description, written twenty years ago, is now of little more than historical interest, the permanent way and rolling-stock of the Mount Washington railway having been since almost entirely remodelled, with the result that little of the original work, except the road-bed, now remains. It is, however, deemed appropriate to record in these pages some particulars of the first mountain railway worked by rack-and-pinion, the work of Sylvester Marsh, a man of singular tenacity of purpose, who had to struggle against great difficulties in the execution of his cherished design, and whose name has not been generally associated with the rack system."

From these early, but successful, attempts to build and operate mountain rack railways have come about seventy-five others of many kinds and of many countries, besides cable and electric mountain lines. As Mr. Schneider, the general manager of the Harz railway, stated in a very interesting paper at the Chicago congress in 1893: "The rack principle, which, in the infancy of railroading, owed its invention to error, has now risen to great practical importance, furnishing as it does the acknowledged safest and most economical means of moving railway cars over steep inclines."

To give details of each of the seventy-seven rack railways now in operation would require a volume, and it would be well worth while to compile the data and to draw useful conclusions from the operation of these roads. It will suffice now to present two tabulated statements (Plates 1 and 2), one entirely devoted to the Abt system, and the other to several other systems. There are essential differences between the various methods. The advocates of each system have apparently sound arguments for their designs, derived from the almost universal freedom from accident on all of these mountain railroads, and from the ease and economy of their operation. The difference in methods consists mainly in the rack and the necessary adaptation of the motor to it. There is given, therefore, a combined sketch of these various forms of rack (Plate 3). The Cathcart plan was applied to the first rack railway for heavy traffic,—a short stretch of railway between Madison and Indianapolis,—in 1847; the maximum grade was about 6 per cent., but since 1868 it has been worked by adhesion altogether. The Locher system was designed by Col. Locher, of Zurich, the engineer who had charge of the Mount Pilatus railway, near Lucerne, the steepest railway in the world,—48 per cent. The Strub system is to be used on the Jungfrau railway, described later, and is the design of Mr. Strub, the chief engineer. The other systems need no further reference. The difference between the two leading systems, the Abt and the Riggenbach, is seen in the two photographs (Plates 4 and 5). There is also shown a photograph (Plate 6) of the Mount Pilatus double-toothed rack.

By far the most important application of the rack-and-pinion method is that used first on the Harz railway in Germany for ordinary commercial purpose. It is still an excellent model for adoption elsewhere. This railway runs from Blankenburg to Tanne, and combines adhesion on grades less than 2½ per cent. with adhesion assisted by rack on steeper grades. It was not until this successful solution of the problem that the people in this extensive country of mountain and valley gained communication with the outer world for themselves and their products.

It will be seen from the comparative sketch of the rack systems that Mr. Abt's rack is not built in ladder-form, like that of Marsh, Riggenbach, and others of that class, but of two or more steel plates, set on edge, with spaces cut out of them in which the pinions of the locomotive engage, so that there may be more than one pinion at work ; also, that the teeth of the multipartite racks are staggered. If two racks are used, the spaces, and consequently the teeth, are set so as to break joints, and the tooth of one plate is opposite a space of the other. If three plates are used, the teeth break joints at one-third of the pitch apart. The Abt locomotive is one of the simplest and, at the same time, most effective and economical motors ever designed for so extraordinary purposes. Its working is easy, and the wear of the plant is almost inappreciable. As an illustration of the most advanced type of Abt locomotive, and to show how powerful it is for freight purposes, an outline sketch is given of a locomotive just designed for a Hungarian railroad (No. 24 of the table of Abt railways). This locomotive weighs about 80 tons. It will haul a train load of 180 tons on a 6 per cent. grade, or 200 tons on a 5 per cent. grade, equivalent, respectively, to six or seven American cars loaded (Plate 8). A photograph of one of the Harz mountain locomotives is also given (Plate 7). Comparing it with locomotives used on most other rack railways, one is immediately struck with its great simplicity. The outside cylinders which move the adhesion driving wheels operate through the whole length of the road. Before the locomotive passes upon the steeper grades, where the rack is used, the two inside cylinders which move the rack pinions are set at work. Mr. Abt has designed a mechanism for allowing the pinions to take the rack easily by setting the first section of the rack on springs (Plate 4). While the rack varies in dimensions on different roads and under different conditions, it is usually made of rectangular plates, about 8 or 9 feet long, 4⅓ inches high, with a width varying with the work it has to do. The plates are usually set as far apart as the the thickness of the plate. This construction forms one continuous rack-bar, and has no weak point, as there are no joints opposite each other. This form of rack is easily adapted to any curve that the car can run on, and allows of very sharp curves. It is the experience on the Harz mountain railway that the contact of rack teeth and the pinion gear of the locomotive is so nearly perfect that the wear on the teeth is practically *nil*, and that on the cogs of the wheel exceedingly small. The calculated wear on the teeth is $\frac{1}{25}$ inch in 150 years, and the cog-wheels will wear 12 years before replacement. Diagrams, showing the wear of cogs in eight years, prove the correctness of these statements. The cost of maintaining the rack is so small on the Harz railway that it has been eliminated as a subject of accounts. The great advantage of

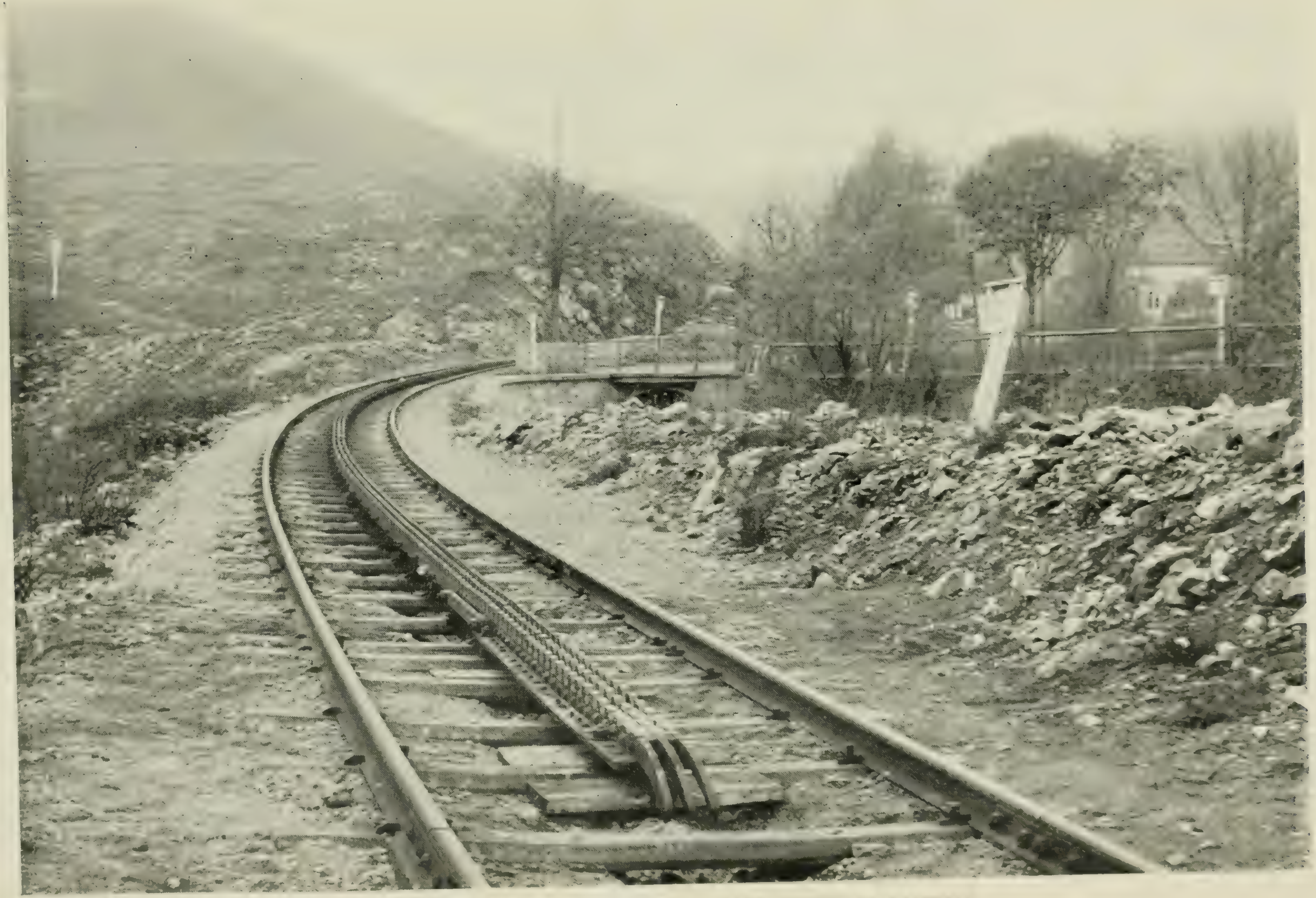

PLATE 4. RACK OF ABT SYSTEM. HARZ MOUNTAIN RAILWAY.

the Abt system of rack is that the strength can be made unlimited by increasing the thickness of the plates and by multiplying them. The system has the further advantage that, owing to the staggered position of the teeth, several thus working simultaneously, great speed can be safely obtained,—say, 15 miles per hour on a 6 per cent. grade. The expense of construction and operation is much less than the corresponding expense in the case of a developed adhesion road surmounting steep inclines. It may be stated, in general, that a rack engine will develop more than twice the tractive power of an adhesion engine. The following table is made up from observations of actual operations.

Grade.	Load per ton of Service Engine Weight.	System.
1 in 28	2.5	Adhesion
1 " 27	2.02	"
1 " 25	1.39	"
1 " 16.67	2.14—2.45	Abt rack
1 " 12.50	1.66—2.35	"
1 " 8	1.55	"
1 " 6.6	1.41	"
1 " 4.	0.78	"

A comparison of the cost of operation on the Harz railway with that on the Semmering railway, an Austrian adhesion road, gives the following :

Cost of raising 1000 foot-tons of load on the Harz mountains	4½ cents.
Cost of raising 1000 foot-tons of load on the Semmering	6 "

Metric measure :

Cost of raising 1000 meter-tons of load on the Harz mountains	0 844 frs.
Cost of raising 1000 meter-tons of load on the Semmerling	1.125 frs.

Several comparisons between adhesion roads of more than 2½ per cent. maximum grade and combined rack and adhesion roads prove that the advantage of the latter on essentially through commercial lines is expressed by a ratio of more than two to one, and that, as the grade steepens beyond 2½ per cent., the ratio of advantage rapidly increases, since the ability of the adhesion system to haul loads rapidly decreases with the increasing grade ; also the possible speed, so that the cost per ton hauled rises very fast. But the great economy of the rack railroad appears in the comparative cost of construction between the same termini. The line of the adhesion road would be more than twice as long, and the cost per mile very much greater. Comparing four adhesion roads in the mountainous countries of Europe with four mixed rack and adhesion roads, we find the former costing nearly four times as much.

An important project now to be undertaken, after several years of discussion, furnishes a good illustration of the advantages of the rack and adhesion method ; I refer to the Simplon Tunnel line. The maximum rack grade is 6 per cent., the maximum adhesion 2½ per cent. The entire line is to be operated by electric motors. Its

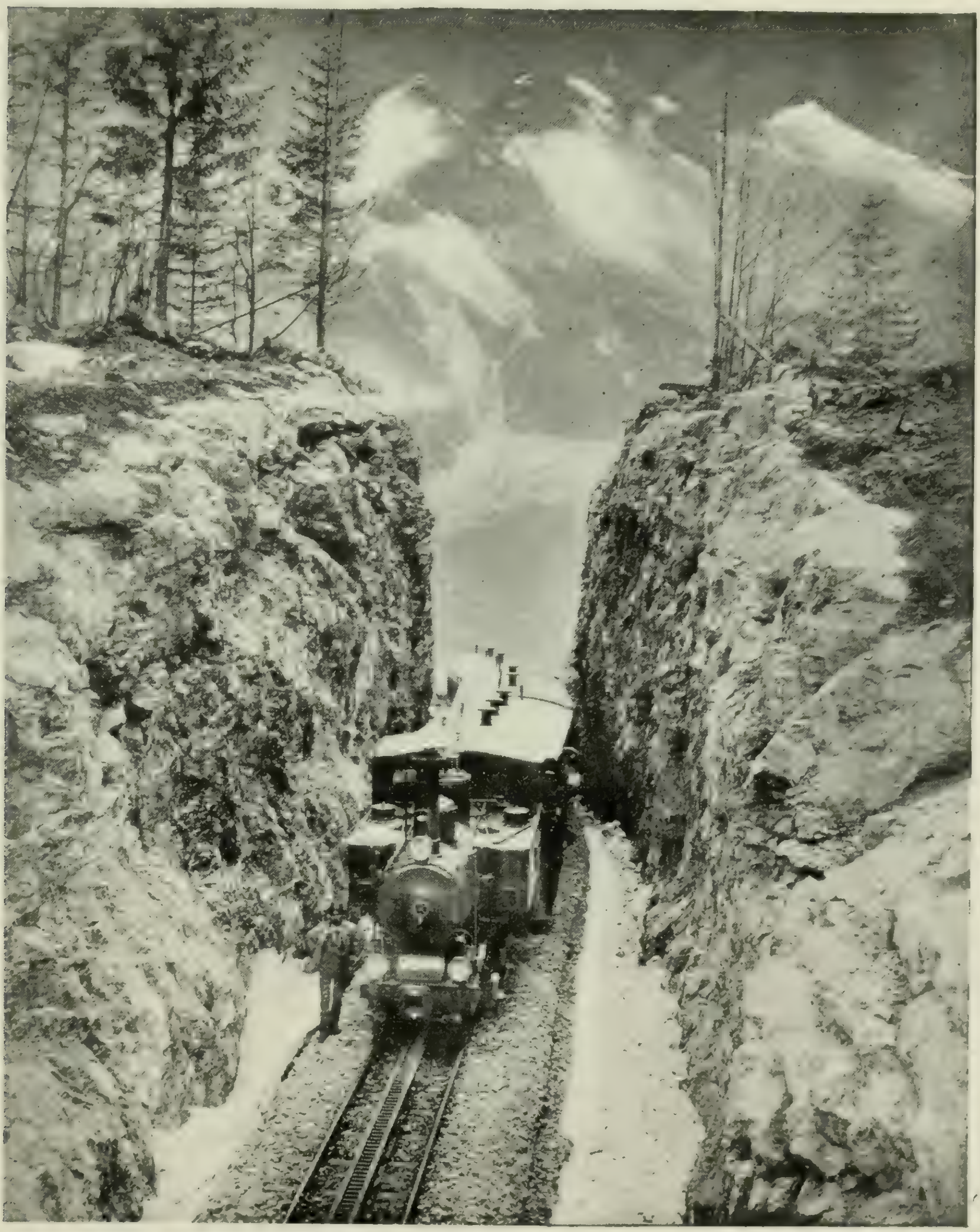

PLATE 5. RIGGENBACH LADDER RACK. BRÜNIG PASS RAILWAY.

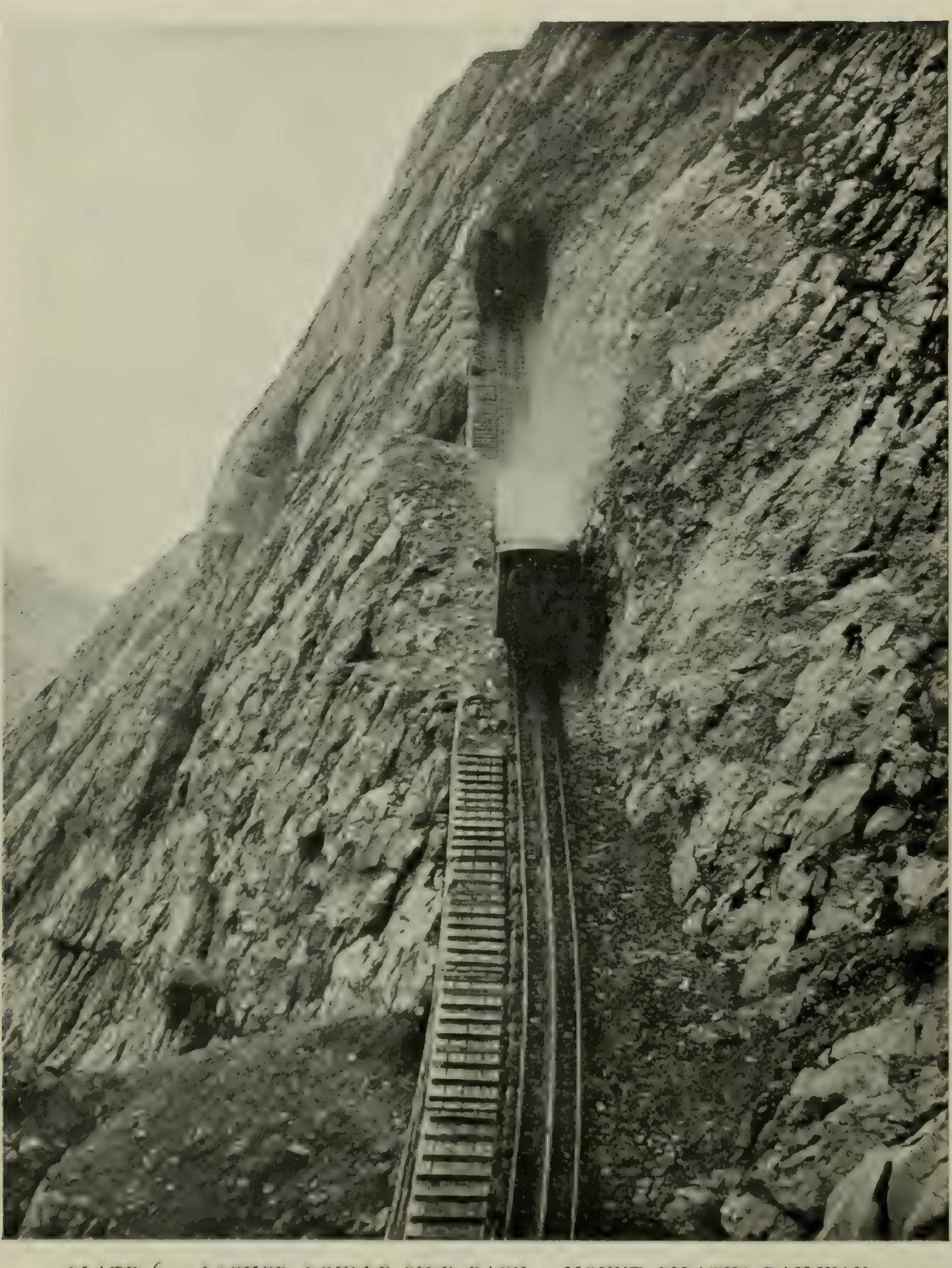

PLATE 6. LOCHER DOUBLE SIDE RACK. MOUNT PILATUS RAILWAY.

length is to be 31 miles, and the estimated cost $8,000,000. The estimated cost of a purely adhesion line is $18,000,000.*

The above observations on the combined rack and adhesion method are corroborated by the report of an important Italian commission, appointed by the Italian State office of public works:

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*Since this paragraph was written, information has come to hand that the plan has been changed to adhesion alone, requiring a tunnel 11¾ miles long. Political and similar reasons—not economy in construction—led to this change.

"After having thoroughly studied this subject, we have come to the final conclusion: 1, that rack railways offer an excellent means for overcoming steep inclines which are beyond the limit of adhesion, and that they make railroad communication profitably possible in mountainous regions where adhesion roads would require the investment of too much capital, and would not pay.

"2, that the slow speed of the rack locomotives is favorable for working the engines most economically, and that the speed, though in itself slow, is, relatively considered, about the same as the average speed on adhesion lines.

"3, that it is practicable, considered from a mechanical standpoint, for cog-wheel locomotives to ascend grades from 3½ to 25 per cent.; but that, from an economical standpoint considered, the grade on combination rack roads with large traffic should not exceed 7 per cent.

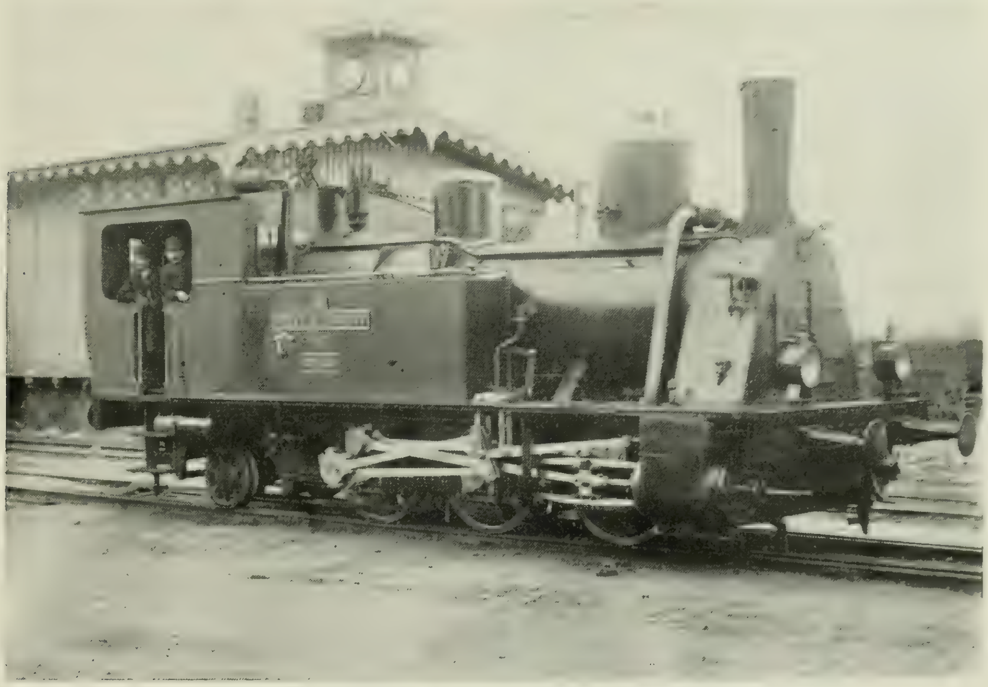

PLATE 7. ABT LOCOMOTIVE. HARZ MOUNTAIN RAILWAY.

"4, that the Abt system for roads with large passenger and freight traffic is preferable to any other rack system.

"5, that the efficiency of a rack railway, even on very steep grades, is considerable, but on grades of 6 to 7 per cent. its efficiency is equal to an adhesion road of 2½ per cent.

"6, that the total operating expenses of a combination rack railway are smaller than those of an adhesion road between the same points; hence, that rack systems can favorably compete with adhesion lines.

"7, that Italy contains many locations where the application of the Abt system would be advisable from a technical as well as from an economical point of view."

We now come to the greatest rack railway project of the age,—the Jungfrau road, which, from its lower terminus at Scheidegg (the summit of the existing rack railways from Lauterbrunnen and Gründelwald), will almost immediately get into the region of snow and glaciers, and reach a height of 13,668 feet, a total rise from Scheidegg of 7,000 feet.

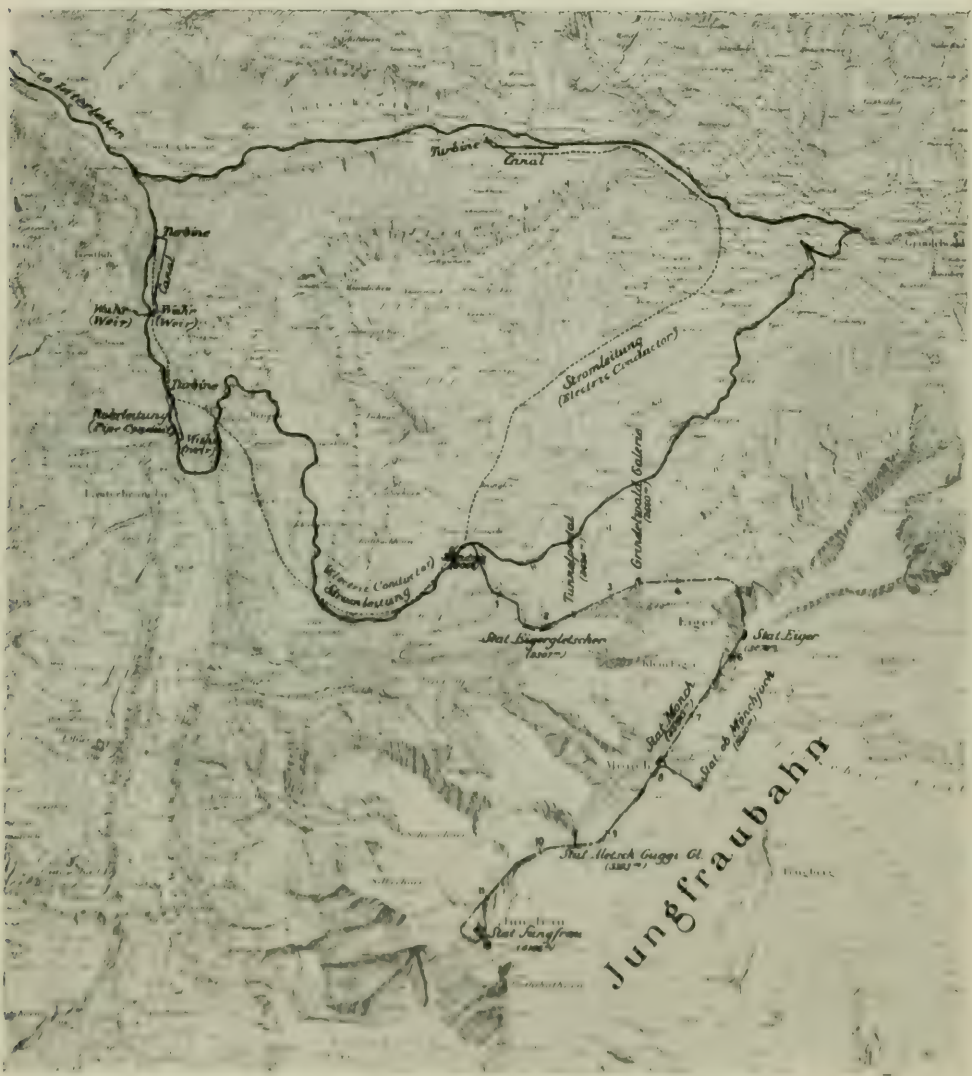

PLATE 12. ROUTE OF EXISTING RACK RAILWAYS AND NEW JUNGFRAU ROAD.

NOTE.

Existing Rack Roads ————————

Jungfrau Road — · — · — · — · —

Electric Conductor - - - - - - - - - - -

Scale, 1 : 50,000.

A wealthy business man of Zürich, Mr. Guyer-Zeller, is the projector, promoter, *concessionaire*, and financier of this important work. He has employed, for the examination and study of the many difficult conditions, able engineers, thorough scientists of international reputation, and photographers. The map (Plate 12) shows the mountains, the glaciers, the snow-covered slopes, the steep, bare, rocky cliffs, the sloping foot-hills, the lovely lower valleys, and the two perennial ice-cold streams formed from melting snows and glaciers,—the White and Black Lütschinen, the one flowing by Lauterbrunnen, and the other starting in the mountain valleys near Gründelwald. It also shows the present rack railways, one leaving the adhesion road at Zwei Lütschinen station, the other at Lauterbrunnen. The first reaches Gründelwald, and the other the same place, by way of Scheidegg, the summit of the present lines. The broken line following the general course of the rack railways is the electric conductor for the Jungfrau line, which will carry electricity from the 6,000-h. p. plant, converting by turbines the water power of the rivers named.

The new road starts from Scheidegg. It is laid in the open—embankment or excavation—for a distance of 1½ miles, as shown by the full line. At this point, after skirting the Eiger glacier, it strikes into the mountain, the face of which is nearly vertical, and continues there for nearly a mile, by a gallery,—that is, a tunnel with numerous slight openings, and, in places, lateral tunnels leading out to open air near by. The section of the tunnel is shown on Plate 10. The line gradually sweeps around the Eiger, but, before changing its course to go due east, a station and outlook, a windowed apartment, is cut into the solid rock (Plate 11). With a spy glass from Gründelwald, these three or more windows will appear very much like a distant view of swallows' nests in a remote sand-cliff.

Then the line, still in tunnel or gallery, swings entirely around to the south side of the Eiger. In the vertical face of this side will be excavated another portal station with windows from which a view one hundred miles southward may be had, and a look down into a mass of green glaciers. Then, continuing in a south-westerly direction, the line strikes the Mönch, under whose summit it is proposed to tunnel out to the daylight for a view in that direction. Thus far the grade rises 25 per cent. Now, to reach the Jungfrau, following what is really a ridge between the two mountains and avoiding the deep glacial valleys, the line descends on a 10 to 12 per cent. grade, and then, by a straight 25 per cent. grade, ascends to a point about three hundred feet below the Jungfrau summit, which is reached by an elevator. The profile (Plate 13) shows the grades and the portion in tunnel or gallery and in the open.

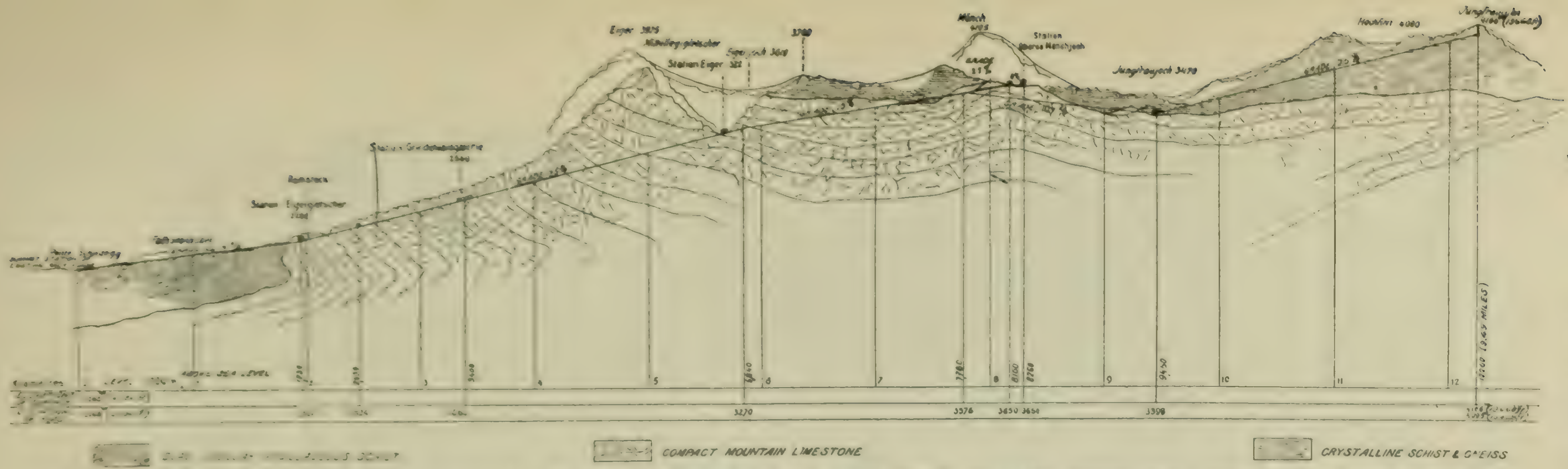

PLATE 9. JUNGFRAU RAILWAY. GEOLOGICAL PROFILE OF THE PROPOSED LINE, BY H. GOLLIEZ, CONSULTING GEOLOGIST. SCALE, 1:25,000.

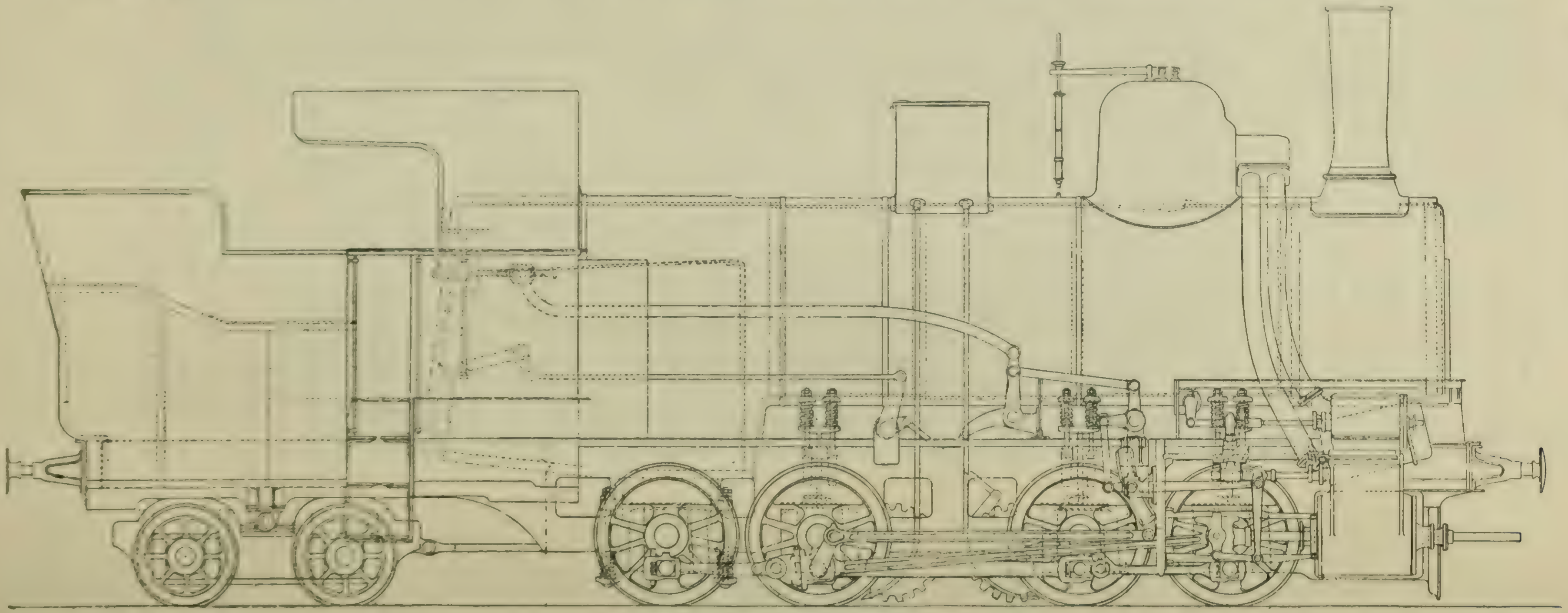

PLATE 8. ABT RACK LOCOMOTIVE.

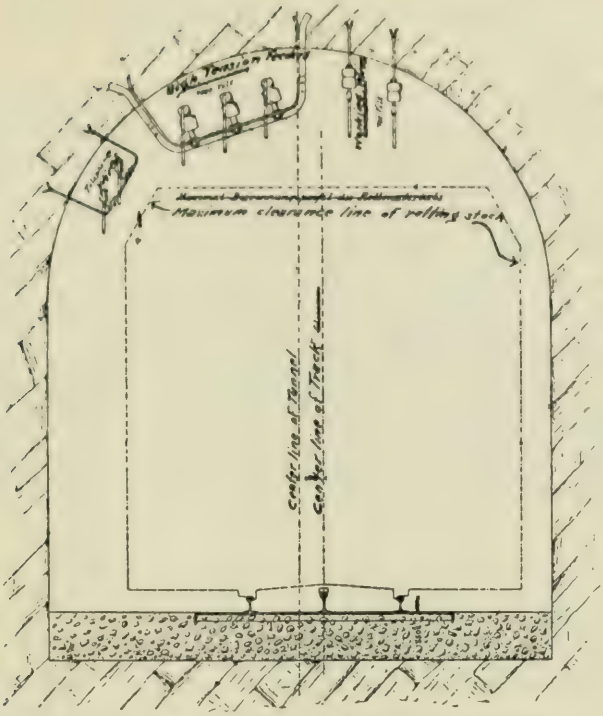

PLATE 10. JUNGFRAU RAILWAY TUNNEL SECTION.

Area of section 13.56 sq. met. (145,959 sq. feet). Scale 1:40.

The comparative sketch of rack plans (Plate 3) shows the rack to be used. The cars will be moved by electric power. The tunnels and galleries will be lighted by incandescent electric lights (Plate 10). The cars and stations will be lighted (and heated when necessary) by electricity, and the tunnels and galleries will be pierced by electric drills.

The materials to be excavated are as follows, according to the report of the well-known geologist, Prof. Golliez, of Lausanne University, and Dr. C. Moset, of Zürich: compact mountain limestone from the second kilometer to beyond the highest point on the Mönch, at about 8½ kilometers; then crystalline schist and gneiss to the top of the Jungfrau (Plate 9, geological profile).

While the proposition for a concession was before the federal parliament and council, the subject was thoroughly investigated. Scientific opinions on "mountain sickness" were given by the topographical engineer, Mr. S. Simon, of Basel, the well-known aeronaut, Mr. E. Spelterini, a committee of the Swiss Alpine Club, Prof. P. Regnard, of Paris, and Prof. Dr. H. Kronecher, of Berne. Without going into the details of these voluminous reports, it is sufficient to say that,

Plate 11, Gründelwald Gallery Station; Jungfrau Railway

acting upon them, the federal government saw good reasons for granting the petition for a concession.

As to the possibility of mountain sickness, there seems to be no further necessity for a scientific discussion on that point, as the summit will not be as high as some others already attained by railroads without harm to passengers or to laborers and others engaged in the work or in the operation of the lines. The highest point, as has been stated, is 13,668 feet above sea-level, and about 7,000 feet above the summit of the existing line at Scheidegg. The Pike's Peak railroad, which has been in successful operation for about four years, carrying many thousands annually to the summit of the mountain from Manitou Springs, is 14,087 feet above sea-level and 7,517 feet above the starting-point at Manitou. The Oroyo Railroad, in Peru, rises from sea-

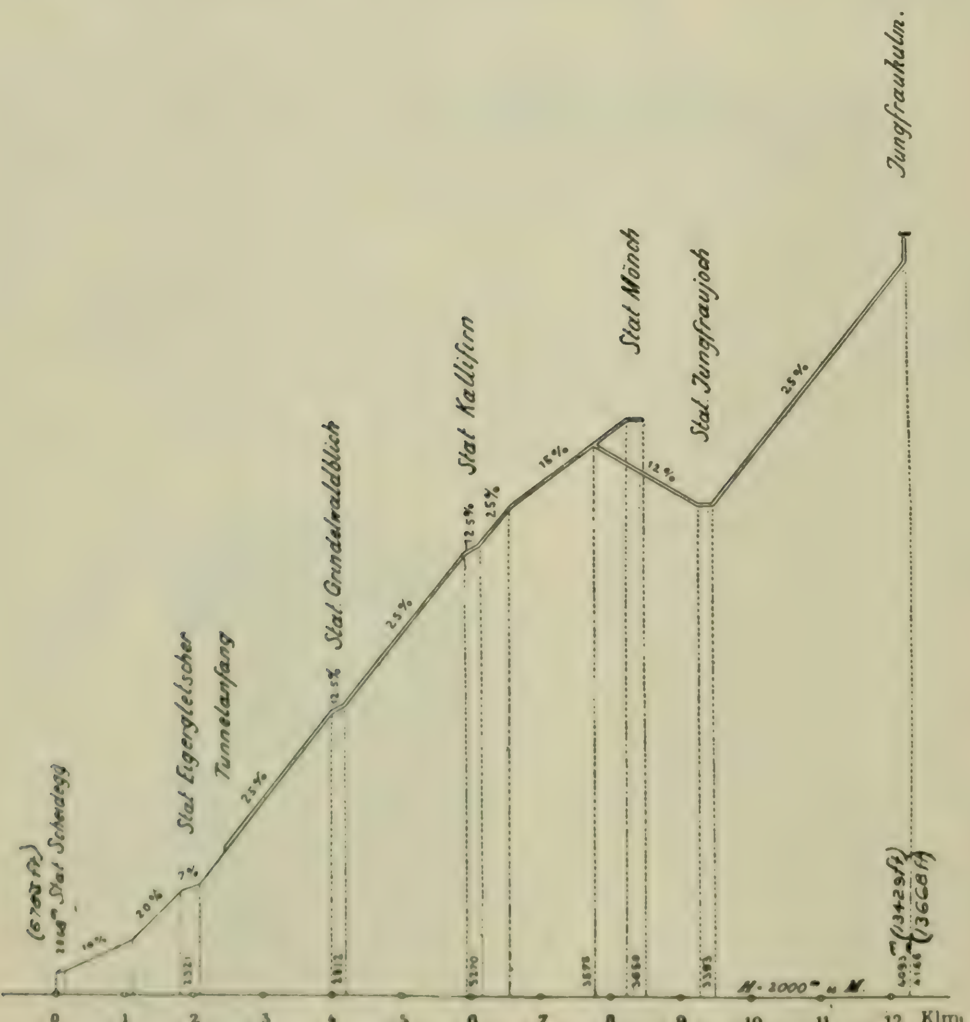

PLATE 13. PROFILE OF JUNGFRAU RAILWAY.

Scales, 1 : 100,000 Horizontal ; 1 : 20,000 Vertical.

level to the summit (15,720 feet) in a very few hours. Several railways in Mexico, the United States, and Canada surmount summits more than 10,000 feet high without injury, or even inconvenience, to passengers. These facts settle that question effectually.

The cost of the entire road and equipment is estimated at $1,930,000. It is to be in operation to some of the lower stations within two years, and to the top of the Jungfrau in about 1902. These estimates, as well as those of traffic and income, were made by a commission composed of some of the most experienced engineers and managers of Swiss mountain railroads. If the construction and operation are placed in the hands of such men, unquestionably the results will be satisfactory. The traffic and income estimates made by this commission are in great detail and extremely conservative. Of the 160,000 visitors at Interlaken in the season of 1895, when the estimates were made, it is estimated that only 10,000 will reach the summit of the Jungfrau. But, as the numbers visiting Interlaken increase now at the rate of about 30 per cent. per semi-decade, and as the Rigi rack railway carried, in 1895, 112,913 passengers and the Mount Pilatus 40,841, the Jungfrau will certainly carry to the summit, in 1902, more than 10,000 tourists, for its advantages from a scenic point of view far exceed those of any other mountain railroad in the world. The concession authorizes a maximum fare, to the summit and return, of $8.68. The average fare actually to be charged is $6.75. The fares to intermediate stations are based on this, and fixed in proportion to the distance travelled, the altitude, and the importance of the station. On this basis, the total receipts from passengers, freight, restaurants, use of water power, etc., will amount to $139,346. Working expenses, renewals and reserve fund, and interest at 4 per cent. on obligations of $1,200,000, amount to $86,850, leaving, for the share capital of $800,000, a dividend of nearly 7 per cent. The writer is of the opinion, after a careful examination and study, that the financial returns will considerably exceed this amount.

THE DISTRICT DISTRIBUTION OF ENERGY.

By Charles E. Emery.

THE distribution of water through aqueducts and pipes for domestic purposes was familiar to the ancients, and in modern times has grown to be of great importance also to manufacturers. The distribution of illuminating gas through pipes has long been well established, and its use for cooking, and to a less extent for heating, is extending. The question of a separate distribution of fuel gas has been frequently discussed ; local distributions have been made for power; and in isolated cases natural gas has been distributed and used for fuel. Steam has also been distributed for both heating and power. In later years the distribution of electricity for lighting and power has advanced with wonderful rapidity. In addition to these forms of energy distributed continuously through pipes and metallic conductors, interest is ever and anon awakened by plans for the transfer of energy in bulk, renewable at intervals, such as storage-batteries charged with energy at a source of power to give out light and power through suitable means wherever conveyed. More familiar is the periodic distribution, in enclosed vessels, of compressed gases for lighting and power. A late modification provides for the production of a brilliant light from acetylene gas generated on the premises in tanks containing "calcium carbid" produced electrically where power is cheap. All these are to be compared with the very homely, but wonderfully effective, distribution in bulk of coal, the greatest storehouse of natural energy,—" black diamonds " indeed, for energy sufficient to supply several horse-power for an hour can easily be carried by a child in a paper bag. All the various subsidiary energies enumerated can be developed by the combustion of coal, and it is a matter of convenience and economy that such energies are severally developed in large quantities, at special stations, for general distribution.

The question naturally arises whether all the methods of distributing energy referred to will survive in the future, it being naturally suggested that one or more will be developed so as to be applicable in a majority of cases for all demands, thereby practically displacing the others. Upon investigation, however, it will be found that each is useful, under proper conditions, in a particular location. It is our purpose at this time to endeavor to ascertain such conditions, for all methods, in a general way, and specially with reference to the district distribution of steam.

We may first consider that heat for cooking, and hot water for culinary purposes, are necessaries of life. In frigid and temperate climates the heating of buildings is at times a necessity. Light is also a necessity, and power derived from nature's stores of energy has, to a greater extent than we can discuss here, released man from the slavery of early existence, and made the higher developments of our modern civilization possible.

The methods of securing these necessities may be briefly outlined as follows:

Heat for cooking, so readily derived by the direct combustion ot wood or coal, may also be obtained from illuminating and fuel gas, and to a large extent from steam, as explained hereafter. Heat from electricity is also available, with some drawbacks.

Light, familiarly produced by burning grease or oil of animal or mineral origin through a wick, is also furnished by illuminating gas and electricity.

Power is readily obtained by the use of steam or gas, and is transmitted readily from any source of power by electricity.

Illuminating gas is produced cheaply, on a large scale, but the generating plant and distributing pipes are expensive, and the capitalization more so, so that, by the time the gas reaches the consumer, there is strictly no economy in the light derived therefrom compared with that from refined oils. Gas, however, is so convenient that, wherever available, it to a large extent displaces all means of producing light from a wick, even in the houses of those of moderate means; and its growing advantages for cooking purposes give it a position from which it will probably never be displaced.

Power is also secured by the use of illuminating gas in gas engines; and for very small powers, or those used occasionally, the cost is not prohibitory. Power has been obtained in England and France by the construction of special gas plants generating a cheap fuel gas on the premises, which is used in gas engines. Some of these plants are of several hundred horse-power, and include a gas generator and gas holder, as substitutes for a steam boiler, and a gas engine instead of a steam engine. The economy is authoritatively stated to be superior to that of a steam engine, but engineers in the United States do not understand why, in that case, the system has not been more largely introduced.

Electricity is available for lighting and to distribute power, but must first be generated at a central station by the combustion of coal, or at a distant waterfall, and transmitted with losses increasing greatly with the distance. The cost of plant and transmission, and generally also of coal, with the inevitable capitalization expenses, make the cost of electric light greater than that from gas. With the incandescent lamp, however, the heat is inconsiderable, and the light is so convenient, and in every respect so desirable, that no modern office-building, store, manufactory, or city or country residence of the very wealthy class, is considered complete without it. Municipal lighting and that of large buildings and areas are secured by means of the electric arc. Moreover, with electricity, power in any desired quantity may be transmitted through metal conductors with entire satisfaction, and with relative cheapness. Electricity has, therefore, come to stay, but cannot, in all locations, displace other means.

It has been shown that electricity may be practically used for heating and even for cooking. The cost, however, is prohibitory, and it is not at all likely that the price of current will be reduced sufficiently to make this method of securing heat an active competitor with steam and gas.

The transmissions in bulk renewable at will are mere modifications. So there remains only the question of the distribution of steam. Cooking by means of boiling can be performed perfectly and economically with steam. Meat may also be roasted in a closed metallic vessel. In the open air, however, the temperature of steam, ordinarily transmitted, is not sufficient to finally scorch the meat and produce the pleasant aroma and taste due to broiling. Steam of very high pressure from circulated water has been used for this purpose, but economical questions in connection with the distribution have prevented the extension of the system.

In any building all the work that could have been done with steam generated on the premises can be performed with transmitted steam. If desirable, a steam engine and dynamo may be operated to generate electric light, and the steam may be used directly through steam engines, or through steam pumps and hydraulic apparatus, or through the electric apparatus, to operate elevators. Moreover, steam power is available at all times to maintain water under pressure in all parts of a high building. The premises can be thoroughly heated, and, if the power be sufficient, exhaust steam can be used for heating with great economy. The exhaust steam contains fully ninety per cent. of its heating value, after losing nearly all its pressure to do the work, though retaining sufficient to produce a circulation in the distributing pipes and radiators throughout the building. By the use of a vacuum pump at the tail of the system, the pressure required for circulation may be kept so low that the back pressure will not reduce appreciably the economy of the engines. The heat, moreover, is much more pleasant, as the lower temperature in the radiators does not "burn the air," as it is expressed, or, more correctly speaking, does not scorch, at least to such an extent, the dust and impurities floating in the air. It may be said that all the advantages due to the use of steam in a building may be obtained by generating the steam on the premises, but, with distributed steam the nuisance of handling coal and ashes is overcome, the heat from the boilers in the basement is removed, and the fire risks are greatly reduced. The steam supplied is, moreover, available day and night without maintaining a force of firemen as well as engineers for the purpose.

The desirability of using steam distributed from a central station, in all cases where it is available, is evident, but experience with the large modern buildings in New York shows that the adoption of the system in such buildings turns principally on the question of relative expense. In some of these buildings several hundred horse power are required, and the plant is of sufficient size to generate the steam almost as economically as it can be produced at a central station. The owners of the district steam system must necessarily pay the interest on the cost of the real estate with the necessary buildings, boilers, and main pipes through the streets to distribute the steam, maintain all these structures, and, in addition, make a profit on the investment; and the augmentation of the actual cost necessary to accomplish this is greater than the slight increase in the cost of coal and operating expenses in the large buildings, due to the maintenance of smaller boiler plants on the premises. The new buildings are extended well underground, so that the high cellars furnish ample room for boilers and the remainder of the steam plant, without injuring the remainder of the building, and in most cases basements are arranged above the cellars, which have important rental value. The distributed steam was introduced in several of these buildings, but was finally displaced for economical reasons.

The distributed steam has, however, been a great boon to smaller buildings, where boilers of proper size either could not be introduced at all, or would so concentrate the heat as to decrease the rental value of the rooms above. In some cases also the expense of an additional man as fireman would be so large a proportion of the total expense as to warrant paying the price charged for the distributed steam. In any event, the distributed steam has been largely introduced in buildings of moderate size, and with it all conveniences of the larger buildings, such as quick-running elevators, steam heat in winter, cold water, and in some cases hot water, on all the floors, etc., so that the owners are enabled to compete for tenants satisfactorily.

The distributed steam has also had a large sale in small manufactories distributed through the district. In such buildings a steam pipe is run in from the street and carried up either from the basement vertically, by the indulgence of the lower tenants, or by supporting it over the stairways, the power being thus introduced to any floor desired, transforming into hives of industry the upper stories of old warehouses scarcely rentable at all under previous conditions.

District steam plants have also proved desirable in residence districts. This is true both in the large cities and those smaller ones where the better residences are practically in the suburbs and surrounded by extensive grounds. In a residence district in a city it may not pay in the summer to keep the plant in operation merely to supply steam for some portion of the cooking in the houses and to maintain the elevator, lighting, and cooking service in the hotels and apartment-houses in the vicinity, but it appears to be a necessity, to be offset by higher prices in winter, the comfort and convenience of the system being sufficient to secure satisfactory patronage. No such question arises in regard to the use of distributed steam in the smaller cities. The plants are made for low pressure, constructed as cheaply as possible, and operated only during the heating season. There are several such plants in cities closely accessible to the coal regions. This gives an advantage to the owners of the plant in securing slack coal at a little more than the cost of haulage, whereas the owners of the dwellings formerly used large and expensive coal for their furnaces. The distributed steam, is, moreover, continuously available, and gives better and more satisfactory service, so that the difference of cost to the owners, if any, does not prevent a generous patronage.

In some cases steam plants have been constructed by the gas companies, the arrangement furnishing a ready market for their coke under the old system of making gas, and the concentration of more business in a single station promoting economy. Some gas companies have also gone into the electric-lighting business to concentrate as much of the municipal business as possible in their own hands and keep out competition.

Some business has also been done in distributing exhaust steam from large electric-lighting stations to buildings in the vicinity. One method of utilizing the exhaust steam, first developed by the writer, is to heat water with the same, and distribute the hot water with pumps, to heat the various buildings.

The influence of the more general distribution of electrical energy on the question of distributed steam for power needs careful consideration. The capital account of the electric plants in the United States is very large ; the original cost was considerable and over-capitalized, and rebuilding, which has been necessary in most plants, required increased capitalization, so that it has been impossible to furnish the electric current at prices which would be considered reasonable for considerable powers. A more liberal policy has recently prevailed, by which current is sold for power at lower prices than for light, and the prices decrease as the quantity of current to single consumers is increased. This has greatly promoted the sale of electric power and operates much as did the distributed steam, originally, to build up small industries. Evidently the electric conductors can be brought into buildings at very much less expense than steam pipes, and, from the absence of heat and waste, the electric motor is more desirable in mild weather than a steam engine. For very small powers, or those used intermittently, the price of the electric current can be high, for the reason that, being supplied by meter, no charge is made when the current is not used, and there is no loss when the motor is not in operation. An elevator in an apartment-house is a good example of intermittent use. When steam is used, condensation is continuously going on, which, though not serious if the pipes are properly protected and operated nearly to capacity, is certainly a disadvantage for intermittent powers. In New York up to the present time the Steam Company has held its power-consumers, and the electric companies have built up their business in other districts. As the matter stands, apparently new industries secure the power available in the particular district. In making new installations the conditions at the particular place need to be considered.

For the future construction of a district steam system, a close study of the conditions must be made in each case. The subject may be considered in relation to two kinds of plants,—*viz.*, high-pressure plants for both power and heating, and low-pressure plants for heating only. In view of the local competition possible in large office-buildings and the availability of electricity, from lighting plants for small powers, it is probable that it would rarely pay, under the conditions obtaining in the United States, to build a high-pressure district system for both power and heating in large cities with a temperate climate. Exceptions should be made where owners of property, in a special district, combine to build a central plant which will start business with a large and established market.

In colder countries, where the necessity for heat extends through a larger portion of the year, and in large European cities, where the insurance is greatly increased by the use of steam boilers in a building, the district system can be adopted with decided advantage, and, in general, a high-pressure system is required. It is advantageous to further extend the distribution of exhaust steam for heating from large stations for generating electricity, etc., and considerable business may also be done in building low-pressure steam plants for use in winter in residence districts, both in large and small cities.

An ideal arrangement for closely-built portions of large cities would be, for the poorer districts, to simply distribute steam and gas, in addition to water, the steam at high pressure so as to encourage small manufactories and operate elevators. Then all the buildings could be heated by steam, and the greater part of the cooking could be done by it, and the gas could be used for lighting and a few culinary operations requiring a higher temperature than that furnished by steam. For the middle and richer classes, in addition to water, low-pressure steam, gas, and electricity should be distributed, the steam to be used for heating and boiling, the electricity for light as required, and the gas for light and culinary operations requiring a high temperature. Thus it would be possible to carry on all the varied operations of life satisfactorily without the direct consumption of a pound of coal in any building.

The writer was called upon in the autumn of 1869 to investigate what had been done with district steam systems, and design one adapted to carry steam of sufficient pressure for power in the city of New York. Steam had already been satisfactorily conveyed considerable distances. The early attempts involved lateral flexure of the pipes. This had been prevented by Holly by anchoring slip joints, but, though he had built many plants, the pipes were drained to each consumer, and the system was in many respects not adapted for power. It was concluded that a system of stuffing boxes with manholes would, in a city, be a continual annoyance which might render the system impracticable. The writer therefore experimented with diaphragm joints, obtaining greater and greater satisfaction as the thickness of the diaphragms was reduced, until finally they were made of corrugated copper less than $\frac{1}{16}$ of an inch thick and supported upon radial bridge plates which prevented the copper from collapsing. This made the expansion joint absolutely tight, and, by moving sample diaphragms under pressure back and forth a sufficient number of times to represent the probable expansion and contraction for several hundred years, it was proved to be reliable for an indefinite period. This system of expansion joint, or "variator," as it came to be dubbed, was employed in all the work of the New York Steam Company in New York city, and has proved satisfactory in every respect. In the original construction a smaller pipe with similar details (since abandoned, as explained hereafter) was laid alongside the other, to carry the water of condensation back to the station.

On account of the great value of land in the lower part of the city, the boilers were arranged in the station in four tiers in as many different stories, with a high story above for coal-storage. In general, buckwheat coal was employed, which would run in chutes down between the boilers, so as to require little shovelling, and, alternately between the boilers, ash chutes were arranged, connecting with the pans under the furnaces, so that, as the fires were cleaned, the ashes ran to the cellar and were there withdrawn in cars, lifted by an elevator to the roof of a rear building, and shot into carts to be carted away. Coal was brought from the docks, and dumped to similar cars in the basement, which were carried up and run out and dumped into the coal-bin in the top of the building. The first station was designed for sixty-four Babcock & Wilcox boilers of 250 h. p. each,—a total of 16,000 h. p. The station was not carried to the full height in the first place, but by 1887 three stories of boilers, or three-quarters the proposed power, had been put in, which, when forced in winter, gave as much power as was intended for the whole station. This station is probably as yet the largest boiler plant in the world, though some of the sugar refineries have plants of nearly the same size. Two of the ocean steamers have developed 30,000 h. p., but this is in compound engines, so that the boilers are really of less power than those of the steam plant.

Many details of a novel character were necessarily devised in carrying out this enormous enterprise, but it will not be possible to refer to them in this article. Among other things a practicable steam meter was devised, and one was placed on the premises of every consumer.

The installation of this plant was not without its difficulties. An opposition company secured a charter, and commenced work in an adjoining district without fully understanding the business. Their pipes were laid on the theory that, by superheating the steam, no condensation would take place, and that it would not be necessary to grade and drain the pipes. The consequence was that, when steam was turned on, it did condense, water collected in the low places, and, when a demand was made for steam beyond this, water mixed with the live steam from the boilers, causing water rams, and the pipes were continually exploding, no less than five explosions occurring at one place. The mechanical construction, too, was bad. Finally, from the accumulation of difficulties, the company succumbed, but its operations greatly embarrassed those of the New York Steam Company, which had no such difficulties with its work. The work of the latter company had, however, been carried on under embarrassments. Notwithstanding the protests of the engineer, the men were privately hurried, so as to reduce the expense, and some bad work resulted which would have been inexcusable under other conditions, and which had to be remedied at great cost. In due time a new difficulty occurred, of the highest interest as showing that no care can provide for every condition. The return pipes began corroding on the exterior, while steam pipes in the same trench, and occasionally in the same conduit, were in no way injured. The rapid corrosion of return pipes was, of course, known, but the writer, in common with others, attributed it to their location in damp cellars, etc. There was no dampness in these trenches alongside the steam pipes, and it was finally determined that the corrosion was caused simply by the fact that the carbonic acid in the atmosphere and soil acts with the greatest virulence at or about the temperature of the water in the return pipes, or a little above the point of boiling water in the open air, the higher temperature of the steam pipes being sufficient to prevent this action. It therefore became necessary, in due time, to abandon the return pipes, and the various drips, through cooling coils in the building, were discharged directly into the sewers, thus keeping the pipes drained as before. The saving due to returning the water of condensation is about one per cent. for each ten degrees that the feed-water entering the boiler is heated, or, for one hundred degrees, about ten per cent.,—sufficient to pay a handsome dividend on the enterprise. It is therefore desirable to use return pipes in building such a plant, unless exhaust steam is available for heating the water ; but such return pipes must be made either of brass or of cast-iron, so as to entirely prevent oxidation, or at least make it so slow as to be of no consequence.

THE ESTHETIC TREATMENT OF ENGINEERING WORK.*

By H. Heathcote Statham.

WITH regard to the vast majority of engineering works carried out in the present day the subject of this paper might be susceptible of treatment as brief as the celebrated chapter "Concerning Owls" in a natural history of Ireland, which merely ran: "There are in Ireland no owls of any kind whatever." So we might say at once: "There are in modern engineering no esthetics of any kind whatever"; engineers in general merely considering how to obtain the required strength with the least expenditure of material and at the lowest cost. It may be replied that engineers are not such heathens; that they introduce columns, capitals, classic orders, carving, etc., into their stone or granite piers or on the fronts of railway stations; that they are known to insert wriggly ornamental work in cast iron in the spandrils of an iron roof-principal, and that they place Corinthian capitals with cast-iron foliage round the tops of the iron columns in railway stations; and, as none of these things are of any practical use, their purpose must be esthetic. But this is exactly one of the points I am about to traverse. *Αίςθησις*, from which we derive "esthetic," signifies perception, in its simplest meaning; and in its derivative and wider meaning intellectual perception as to form and fitness of execution. But there is not much intellectual perception in clapping upon a work some kind of architectural detail which in no way belongs to the construction or has any suitability in connection with it, merely because it is supposed that the public expect to see something ornamented there.

Architects do this to a considerable extent, no doubt; but at the worst they do it with a certain perception as to suitability of expression. In fact, the object of an architect (whether he succeeds in it or not) is to produce a structure which shall be pleasing to the eye and to the sense of taste,—a matter about which the engineer cares not a button. So long as the structure performs its practical function, an engineer not only does not care how ugly it is, but rather boasts of his indifference on that score. In fact, he does not understand why you call it ugly. And this is the point on which architects may certainly claim to have a distinct advantage over engineers. Although there is much special constructional work done by engineers the details of which are not familiar to architects, there is nothing in the constructional work of engineering which an architect cannot fully understand and appreciate. But there is a good deal in architectural design which engineers seem quite unable to perceive the value of, and this in relation not only to modern architecture but to works of the great period of building. I have stood with two engineers in one of the best bits of thirteenth-century interior architecture in England, and been asked by them: "What is it that you admire in this?" the question not being put in the way of a sarcasm, but, like Miss Dartle's questions, "for information," which, of course, I was unable to impart; it was a question of perception, not of information. In short, architects understand engineering a great deal better than engineers understand architecture.

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* Mr. Statham handles his subject without gloves, as is fitting in an essay addressed to intelligent engineers, with whom the question will always be, *not* "is it pleasant?" but "is it true?"

The matter of suitability, composure, and grace of design is even more important in mechanical work than in the larger constructions of the civil engineer, to which Mr.

The main reason for this probably is that an engineer's esthetic perceptions are absolutely atrophied for want of exercise and training. The whole of his professional education, which in most cases begins in a foundry or an engine-building yard, is directed solely to the consideration of practical construction, of the way things are put together, not the way they look. He is never encouraged to think about what is called the "design" of a piece of work; he does not clearly realize what design means, and he lives and works among people who do not. But, as he gets into practice and has to carry out such works as railway stations, railway viaducts, etc., on a large scale, a vague persuasion comes over him that these things are expected to be "handsome;" other works of a similar kind, he sees, are thus made handsome; ornaments are stuck on them; pilasters, finials of various kinds, big scrolls of foliage, etc., the contemplation of which seems to arouse the reflection, "go thou and do likewise," or even "handsomer." The *raison d'être* of the matter, the relation of the ornament to the construction, is not considered at all. A local borough engineer, an excellent and

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Statham more particularly addresses his criticism, because it is more directly convertible into a money equivalent. Instances of a bridge design standing or falling on esthetic merits are, perhaps unfortunately, rare; but the machine-tool will often find acceptance or rejection as its appearance is pleasing or the reverse. Nowhere will useless ornament be more utterly condemned, but nowhere will the merits of fine design and artistic workmanship be more quickly and more practically recognized. The salesman can readily dispose of a handsome tool, remembering that one great element of beauty is adaptation to intended purpose; an awkward or unsightly machine stands already half condemned in the eyes of the prospective user. For this reason it is especially desirable that modern machine-designers should study the principles of design, and profit by the authoritative and searching criticism that Mr. Statham offers.—EDITOR.

most competent man in that capacity, brought me one day four designs he had made for a stone bridge over a roadway in his district, which it was proposed to pull down and rebuild (I believe much more because it was old-fashioned than for any practical reason). That he should have thought an architectural opinion worth having on the point was an indication that he desired at least to do the best he could in regard to the appearance of the new bridge; that he should have asked my own opinion in particular was a compliment which I fully appreciated. But the case was hopeless; all the designs were covered more or less with bad architectural (?) detail, having no relation to the construction; all I could do was to recommend the adoption of the plainest design of the four, on the principle that, as all the detail was bad, the less there was of it the better. "But why do you select the very plainest of the four?" quoth the engineer.

That is just one of the points that one cannot get the modern engineer to understand. A piece of bold scientific construction, especially on a large scale, is a great deal more effective, more interesting, even more picturesque, if left to itself, than if concealed or be-devilled with bad ornament. I remember an illustration in an American engineering paper (I forget which) of a large railway viaduct carried across a valley (I forget where), consisting only of plain lattice-girders laid across the tops of a succession of massive truncated pyramids of rough coursed masonry, without any attempt at ornament or architectural detail of any kind. But the massiveness and simplicity of the thing made it picturesque, and one could not help thinking that, if engineers would be more often content to let well alone in this way, and trust to the inherent impressiveness of simple structure, they often would receive blessings from the esthetic mind, instead of something quite the reverse. To instance a case more in detail: There is a large iron roof in London, of very scientific structure, one very wide center span and a narrow aisle (to borrow an architectural term) on each side. The horizontal girders over the "aisles" form an abutment to the arched girder of the center span, and the outer ends of the "aisle" girders and the springing of the center girder are carried on a column under each principal. These columns are made slightly fish-shaped, swelling in the center of their height and tapering to top and bottom, both ends being rounded and working in a cup at top and bottom, so as to be free to move with the expansion and contraction of the center span. The effect, where the roof had just been set up, was not only most workmanlike, but really graceful. In a corner of the ground I came on a whole heap of cast-iron Corinthian capitals; what were these for? It appeared they were to be fitted round the tops of the columns to conceal the real construction, and to show a capital where a capital was generally found. "Why!" I said to the engineer, "you have done a first-rate thing, and now you are going to spoil it with this gewgaw." He saw the point well enough, but his defence was that the public were so accustomed to see a capital at the top of a column that without it they would think the structure unsafe! There are many engineers, however, who would not even have recognized that there was any reason in the criticism. As to the public, they never look at an iron roof, or consider whether it is safe or not; they accept that in faith. But, if they do expect to see a useless cast capital round the top of an iron column, it is the engineers who have taught them the lesson. Why not unteach it?

The greatest engineering structure of modern times, the Forth bridge, is an example of simplicity of treatment, not perhaps so much on principle as because the vast scale of the work put anything like ornamental treatment out of the question, which was probably the better for the total effect. The Forth bridge is, in fact, a colossal trestle bridge, with no more pretence to architectural design than a builder's timber scaffold, which, it may be observed, is often a rather picturesque object. The bridge has something of the same kind of picturesqueness, together with the impressiveness arising from its enormous scale. Yet, though we certainly do not want it ornamented, something might have been done which has not been done. The Forth bridge is, in fact, a rather typical example of one of the common faults of engineering design,—*viz.*, the ugliness and artistic clumsiness of the manner in which connections are made. It seems to be considered enough to rivet one piece up to another in whatever way may be the strongest (or strong enough) for its purpose, without any attempt at shaping the connecting parts or forming a harmonious line. This is constantly to be seen on a smaller scale in such things as the connections of strutts or tension bars with main ribs in roof girders. There is not the slightest attempt to shape the working portions. Without any ornament at all, some attempt at shaping would make all the difference in the general aspect of work of this kind. That is one of the great differences between medieval and modern metal work; the medieval workman always had that *shaping* instinct, and never left his junctions awkward and clumsy in appearance. Of course his iron work was on a much smaller scale; but the principle is the same in large as in small work, and in most iron work on a large scale it could be applied if there were the desire for it; its neglect is the result of sheer indifference. The enormous scale of the Forth bridge may put it in a special category in this respect; but still even here something better might have been achieved. Standing on one of the piers, for instance, one sees the base or foot of the great curved member of the cantilever looking as if the whole weight and thrust of that member were taken by the mere edge of a steel plate; it is not really so, of course, but it has that appearance, and nothing could look worse. It is characteristic, too, of the spirit of modern engineering that the curved member, to save trouble in fitting, was not made a true curve, but a succession of short straight tubes, each fitted at a slight angle to its predecessor. The bad effect is not so very obvious on a side view of the whole elevation, but it is very obvious on an oblique view, when the cantilever is seen foreshortened; it is noticeable even in a comparatively small photograph, and gives a strangely coarse and crippled effect to the appearance of the whole. It is impossible to suppose that the manufacture of a true curve would have presented any real difficulty, but it would have been rather more expensive to carry out, and, for the sake of that, the appearance of the structure has been consideraby injured. The whole subject is one which engineers ought to take into consideration; it is really a question of the most perfect and workmanlike manner of doing a thing. "Art," said Mill, "is the endeavor after perfection of execution"; and, though that is an imperfect definition and will not include all the aims of art, it includes the main part of what goes to make a plain structure a work of art. It is a question of joining two parts not merely in the strongest manner, but in the *best* manner; and the best manner means that which combines neatness and finish of line and appearance with strength. This may seem a small thing in itself, but greater attention to it would make an immense difference in the artistic effect of engineering works.

Another weakness in engineering works in iron and steel is their terminations; terminals is perhaps the proper word. In the case of such objects, for instance, as built-up steel towers or standards for taking the chains of a suspension bridge, engineers in general seem to have an idea that these erections cannot be considered complete without the most extraordinary and preposterous finials being formed on them,—things which remind one of the old-fashioned forms of decanter-stopper, greatly magnified in scale and exaggerated in character. It is impossible to imagine why engineers put details of this kind on their works; they are nearly always hideous in outline and character and in the most tawdry and vulgar taste. This is another instance of the bad results that are obtained because engineers cannot be content to leave well alone. We presume they must imagine that these decanter finials are an ornament; but the real fact is that, if they put nothing at all, the effect, in the eye of any artist, would be infinitely preferable.

In regard to masonry structures it is worth notice that, as late as the beginning of the present century, English engineers could turn out really grand works, such as London bridge and Waterloo bridge. The contrast between these works and the gewgaw style of many of our modern bridges is again an example of the importance of reticence and dignity of design, and of the sad results produced by the fancied necessity for covering engineering works with bad and misapplied architectural detail. Look at London bridge, a really grand work, but which is so mainly from the fine line of its arches and the plain, massive treatment of the whole. Except the plain modillions under the cornice, there is not an architectural feature, in the usual sense of the term, in it. Compare this with Blackfriars bridge, with its great polished granite columns on the piers, looking adequate to carry a tower, and carrying in reality nothing but the small balcony-like projection over the pier; look at the coarse, tawdry carved ornament of the capitals of these columns, and realize what a fall this is from the simple and unpretending dignity of London bridge. The last Thames bridge, the Tower bridge, is even worse; it is the most terrible and monstrous piece of sham ever erected. The masonry towers, considered *per se*, are very poor concerns,—tawdry Gothic, totally deficient in breadth of style or power of effect,—but they become simply contemptible when we know that they are only masonry skins carrying nothing, and, in fact, supported by the steel work which they conceal. To make the farce complete, the heavy suspension chains of the side spans of the bridge are led up through "hawse-holes" into the masonry, so as to keep up the pretence that the towers are supporting the chains, which would, in fact, pull them down immediately. This is one of the cases in which one feels that the naked exhibition of the steel structure, with no pretence at architectural treatment of any kind, would have been infinitely preferable to this foolish piece of elaborately-constructed scenery.

Another of the points in which the modern engineer is so woefully at sea when attempting what he supposes to be an ornamental treatment of his structure is the scale of the details. The engineering idea seems to be that in making mouldings and ornaments for a big work it is simply necessary to magnify everything in proportion; to have great lumps of mouldings, imitations of those which are commonly used on a smaller scale, and enormous carved or cast ornamental foliage and other such horrors. Instead of increasing the sense of scale in the structure, that is just the way to decrease it. One of the most extraordinary instances of this is to be found in the present Hammersmith bridge over the Thames, designed by the late engineer to the London county council,—a structure which, in fact, is almost an epitome of all the faults of the day in regard to engineering design. It is an iron suspension bridge, with towers apparently designed to imitate stone ones, with portentous finials; and at each end, at the shore approaches, the side of the bridge is decorated by an enormous piece of classical-looking acanthus scroll in cast iron, about fifteen feet long. When giving a lecture on the bridges of London to the London Architectural Association, a little while since, which was illustrated by lantern views, I had secured a good end view of one of these wonderful pieces of detail, and, if any engineers had heard the roar of laughter with which its appearance on the screen was greeted, they might perhaps have become convinced that there must be something radically wrong in their way of doing things.

The fact is that engineers evidently do not believe that there is any such thing as an art of design at all. They think that, if they want to make a thing "handsome," all they have got to do is to clap upon it some of the features which they are accustomed to recognize as architectural embellishments, such as pilasters, and carved capitals, and spikes and spirelets and finials, making them much bigger and coarser to suit the scale of the work, and the thing is done. What engineers require to learn is that design is an art not to be appreciated and understoood without systematic study and training of the mind to that end; and that, in attempting to handle it without that kind of training, they are merely cumbering the ground with absurdities and making themselves a laughing-stock. If they reply that the study of the practical problems of their profession leaves them no time for the study of design, there are two courses open to them,—either to engage an architect to work with them as far as the design is concerned, or to make up their minds to leave design, in the higher sense, alone, and to be content to construct merely, and to leave their constructions in severe simplicity. There are cases in which this latter is on every ground the best course to pursue. The structural elements of a suspension bridge, for instance, are so charming in themselves that no "treatment" can improve such a structure, and the more simply it is treated the more pleasing it will look. There are many other cases in which, as in the instance of the American railway viaduct already referred to, a perfectly simple and unadorned treatment may be picturesque, and will at all events be inoffensive. The worst offences against taste in modern engineering structures come from the wish to do something showy. Apart from this, the weakest point in engineering works is the bad and clumsy designing of junctions and connections. An improvement in this one respect would make a great difference in the attitude of the architectural mind towards the work of the engineer.

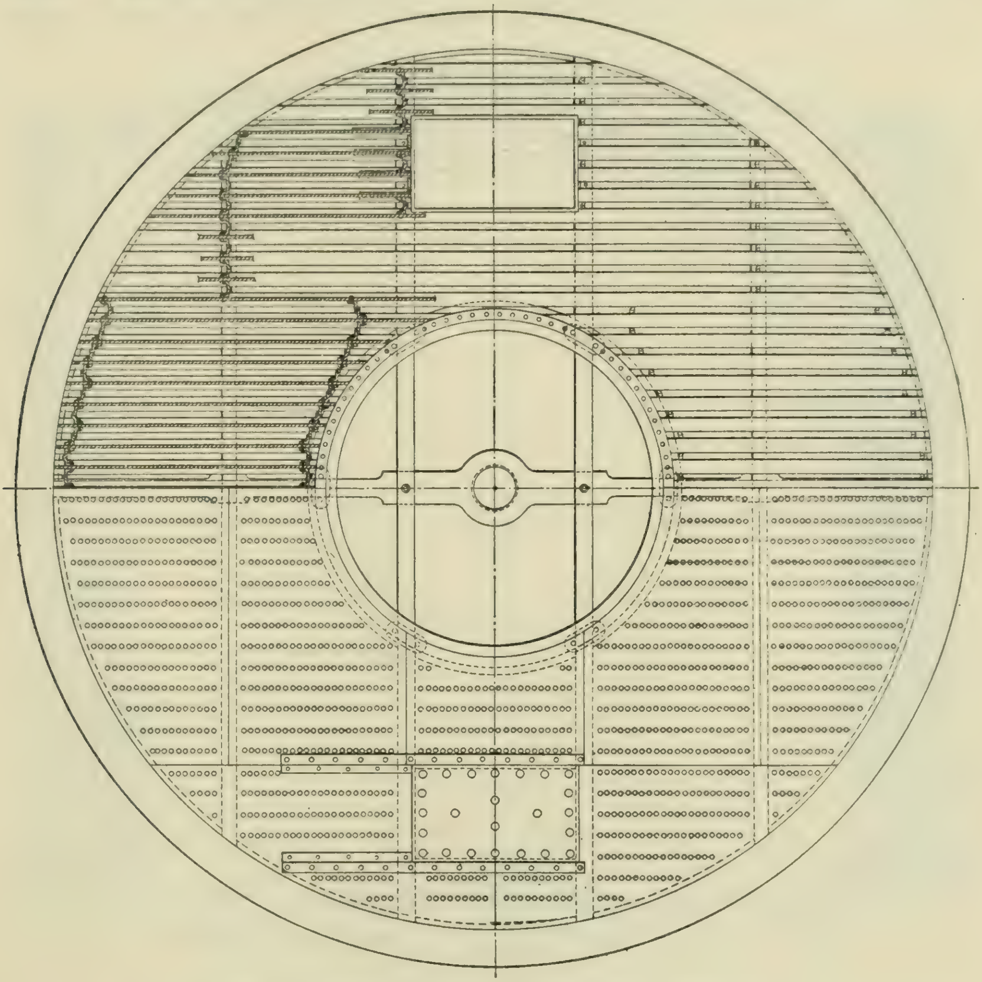
ERICSSON'S FIRST MONITOR AND THE LATER TURRET SHIPS.

By George L. Fowler.

DURING the decade from 1850 to 1860 the maritime nations of Europe came to a partial realization of the fact that wooden walls had ceased to be an effective protection against the artillery of an enemy, and the tentative construction of iron-clads was begun in England and France. In 1854, during the war of the Crimea, Captain John Ericsson, desiring to assist in striking a blow at Russia, the hereditary enemy of his native country, Sweden, offered to the Emperor Napoleon the plans of a vessel of peculiar construction, and one so designed as to be invulnerable to any artillery that the Russians possessed. It was a turreted vessel, but, after examining the plans, the emperor sent word to the inventor that, while greatly interested in the design, he thought that the small number of guns which could be mounted would render the vessel incapable of holding its own with those against which it would be pitted, and declined to build one as an experiment.

The plans were, therefore, laid aside, and nothing was done with them until after the breaking out of the civil war in the United States. In the fall of 1861 the Confederate forces, in possession of the navy yard at Norfolk, Va., raised the old frigate Merrimac and converted her into a most formidable fighting machine. Mr. Mallory, who was the secretary of the navy for the Confederate States, seemed to have realized that a single powerful iron-clad would prove more serviceable than any number of men-of-war of the ordinary type in raising the blockade of the southern ports, and it was in accordance with this idea that the Merrimac was reconstructed. Her engines were wholly unfitted for the work put upon them, and were incapable of giving the vessel much more than bare steerage way, yet, defective as the vessel was, the moral and physical efficiency was enough to raise the hopes of the south to the highest pitch of jubilation and throw the north into a state bordering on panic, culminating in the destruction of the Cumberland and Congress.

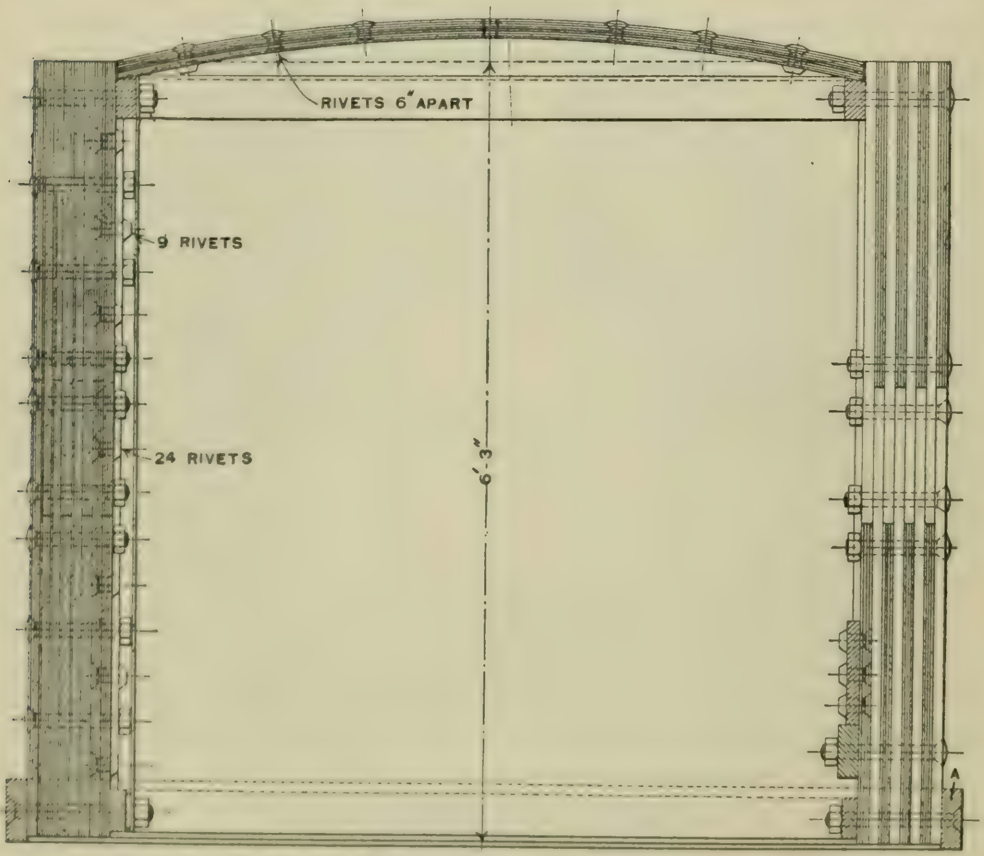
Meantime Ericsson had presented his plans of a "fort upon a raft" to the navy department to have them declined; then by a special commission they were voted against, and it was only by a trick on the part of one of his friends that the inventor was induced to appear personally before the board and succeeded in persuading them that the plan would be a success. He agreed to build the Monitor in one hundred days, at his own risk, and to refund all moneys paid on account if the vessel failed to sustain the fire from the enemy's batteries. The navy department kept up a constant nagging during the whole period of construction, urging him to speed, casting continual doubt on the successful outcome of the experiment, and hampering the contractors by withholding the payments on account, while the press dubbed the vessel "Ericsson's Folly," and complained of the waste of money involved.



PLAN OF ROOF OF TURRET, ERICSSON'S MONITOR.

Then came the meeting of the giants. Each represented a type that was fighting not only for the causes which it represented, but for its own existence as the fittest to survive and be the prototype of the future fighting machines of the navies of the world. We all know that the Monitor with its revolving turret was the victor, though at the time both sides claimed to have had the better of the fight, and subsequent opinions are united that the new turret ship was unskilfully, though bravely, fought, as would have been expected from men just over a very trying sea voyage and in a ship fitted with new and untried machinery. But, whether the day belonged to the Monitor or not, certain it is that the ultimate victory belonged to the turret type.

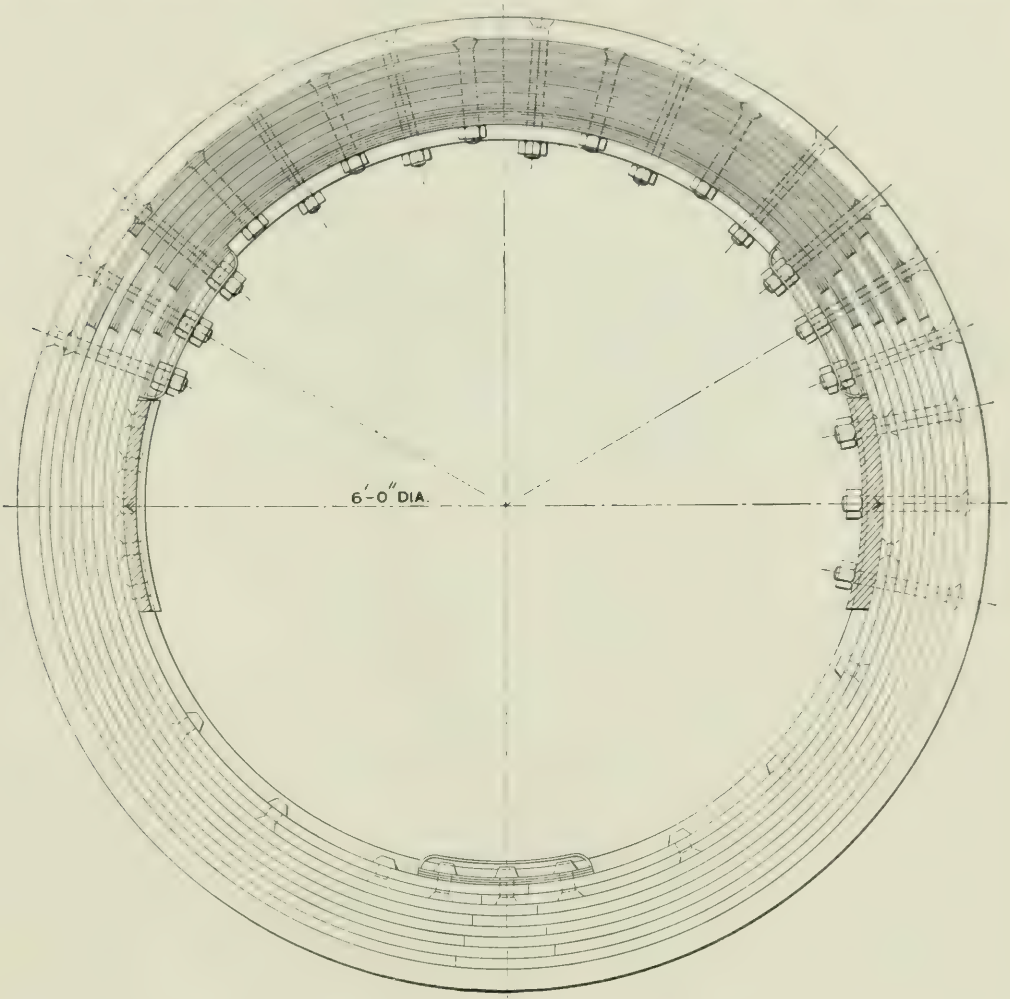
The Monitor may be described as a raft with a hull or air chamber beneath to give the necessary buoyancy to carry the fort that is placed above. The hull was entirely protected by the upper works, with which we are chiefly interested. The raft or platform was 174 ft. long, 41 ft. 4 in. wide, and 5 ft. deep, while the hull beneath had a length of but 124 ft. and a beam of 34 ft., thus giving an overhang at the water edge of 25 ft. at each end and 3 ft. 7 in. at the sides. The sides of the platform were perpendicular; and were built of white oak for a thickness of 2 ft. 6 in. protected by iron armor plating 6 in. thick.



VERTICAL SECTION OF BUILT-UP TURRET, ERICSSON'S MONITOR.

Upon this deck the cylindrical turret was placed. This had an internal diameter of 20 ft., and was 9 ft. high. There were two port holes 6 ft. above the deck for the guns on the same side, and these guns were 11-in. columbiads firing a shot weighing 184 lbs. and using 15 lbs. of powder. These guns were mounted on carriages moving in slides of forged iron that extended all the way across the turret.

The turret was composed of concentric rings of 1-in. iron set vertically and firmly bolted and riveted together, but having no horizontal joints, and presenting a thickness upon the fighting side of 11 in. and of 9 in. on the opposite. The plates overlapped or broke joints so that only a single joint was presented at any one place, and they were put together after the manner shown in the engraving of the pilot house. The roof was formed of forged beams covered with perforated plate iron, and was braced on the lower surface against the sides of the cylinder. There were two sliding hatches in this roof, by which access was gained to the interior of the turret.



HORIZONTAL SECTION OF BUILT-UP PILOT HOUSE, ERICSSON'S MONITOR.

The weight was sustained by a vertical shaft 10 in. in diameter that rested in a cup supported by a bracket firmly bolted and braced to the main bulkhead of the vessel about half way down. The machinery for turning the turret consisted of a double-cylinder engine driving a pinion that meshed in with a spur wheel of 6½ ft. diameter and 11-in. face fixed to the shaft that carried the weight. The circumference of the turret rested upon a turned composition ring set into the deck,—an arrangement that was soon changed in subsequent vessels for supporting rollers.

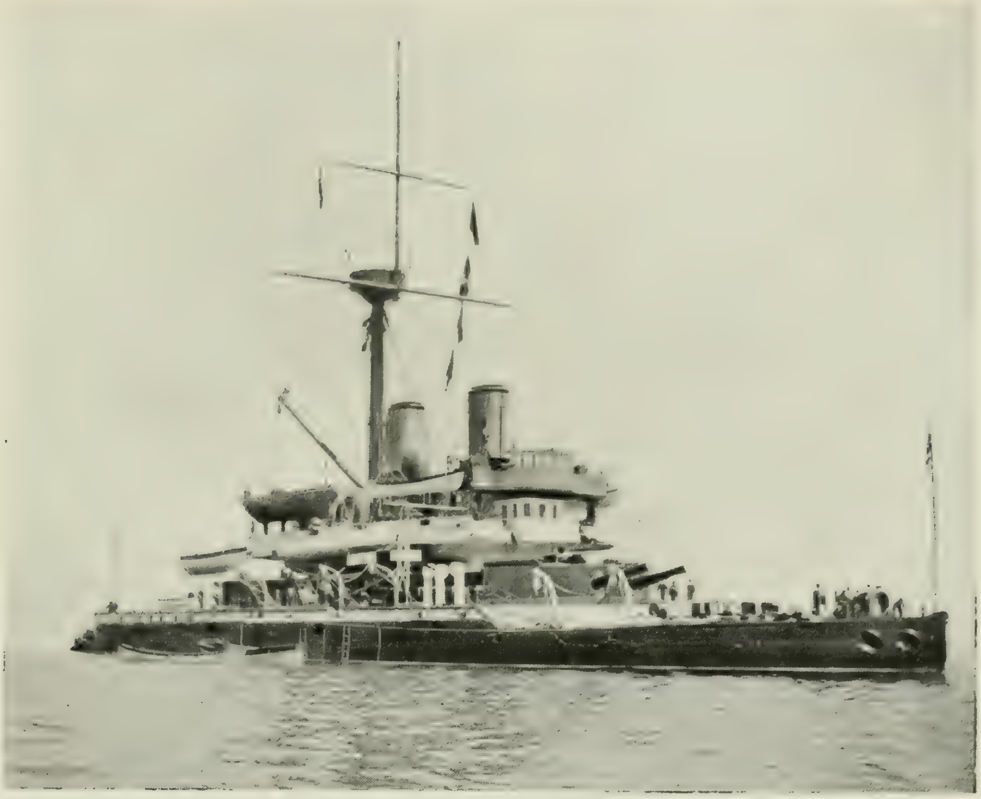
While the turret was capable of delivering an all-around fire, the actual working of the vessel was somewhat handicapped by the fact that the pilot house obstructed the direct fire forward and the smoke-stack that aft,—a condition that was removed in the later vessels of the "Monitor" type by placing the pilot house or conning tower on the roof of the turret and lowering the smoke-stack.

The engravings of the section and plans of the pilot house show the methods of construction of it and the turret. At that time there were no mills capable of making the thick plates now in use, and the system of bolting and riveting shown was used. The base of the pilot house was strengthened by the ring A, which was turned all over and carefully fitted in position.

The success of this private vessel was such that it was immediately followed by the construction of several others, while some iron-clads of the "Merrimac" type were built for service on the western rivers.

Abroad the influence of the new type was instantaneous, though actual construction was somewhat tardy of realization. A sort of inverted revolving basin had been suggested to the English admiralty a year or so before, and had been rejected; but the battle of the Monitor and Merrimac in Hampton Roads caused the scheme to be revived, and the Royal Sovereign was converted into a turret ship. This vessel was originally a three-decker, and was cut down and plated with iron armor 5½ in. thick, and fitted with four turrets, having two guns in the one forward and one in each of the others. In order to obtain more freeboard at sea, light iron bulwarks 3 ft. 6 in. high were hinged along the sides, and were to be turned down when it became necessary to fight the guns. The turrets, instead of revolving on a central pivot, as in the case of the Monitor, were supported and rotated upon rollers,—a construction that has been followed ever since.

Although the orders for the conversion of the Royal Sovereign were given in 1861, it was not until 1864 that it was completed. H. M. S. Devastation was the first seagoing mastless ship to be constructed; for, though the Monitor did go to sea, it was intended only for harbor operations, and the original contract required that

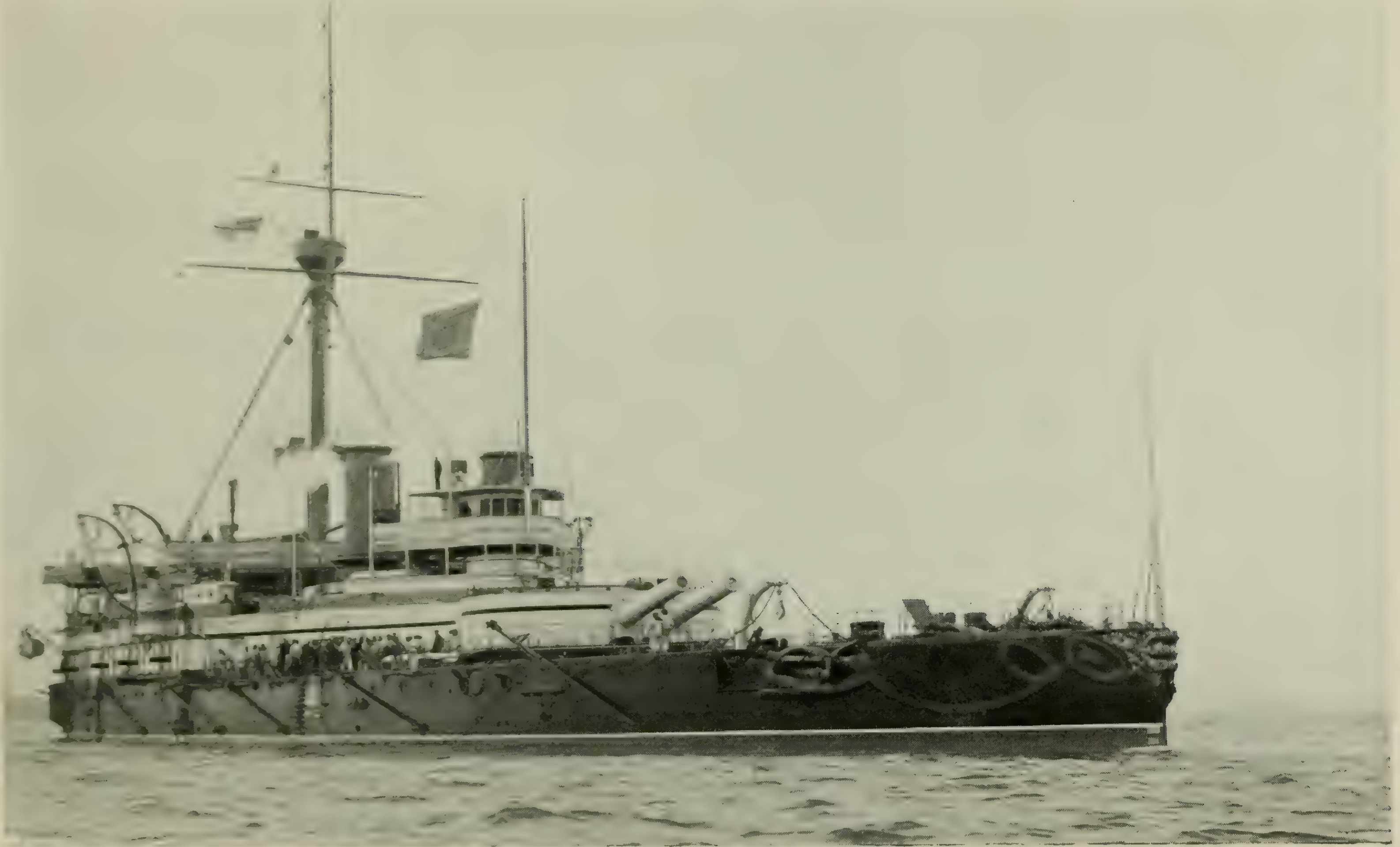


H. M. S. DEVASTATION—A TYPICAL TURRET SHIP.

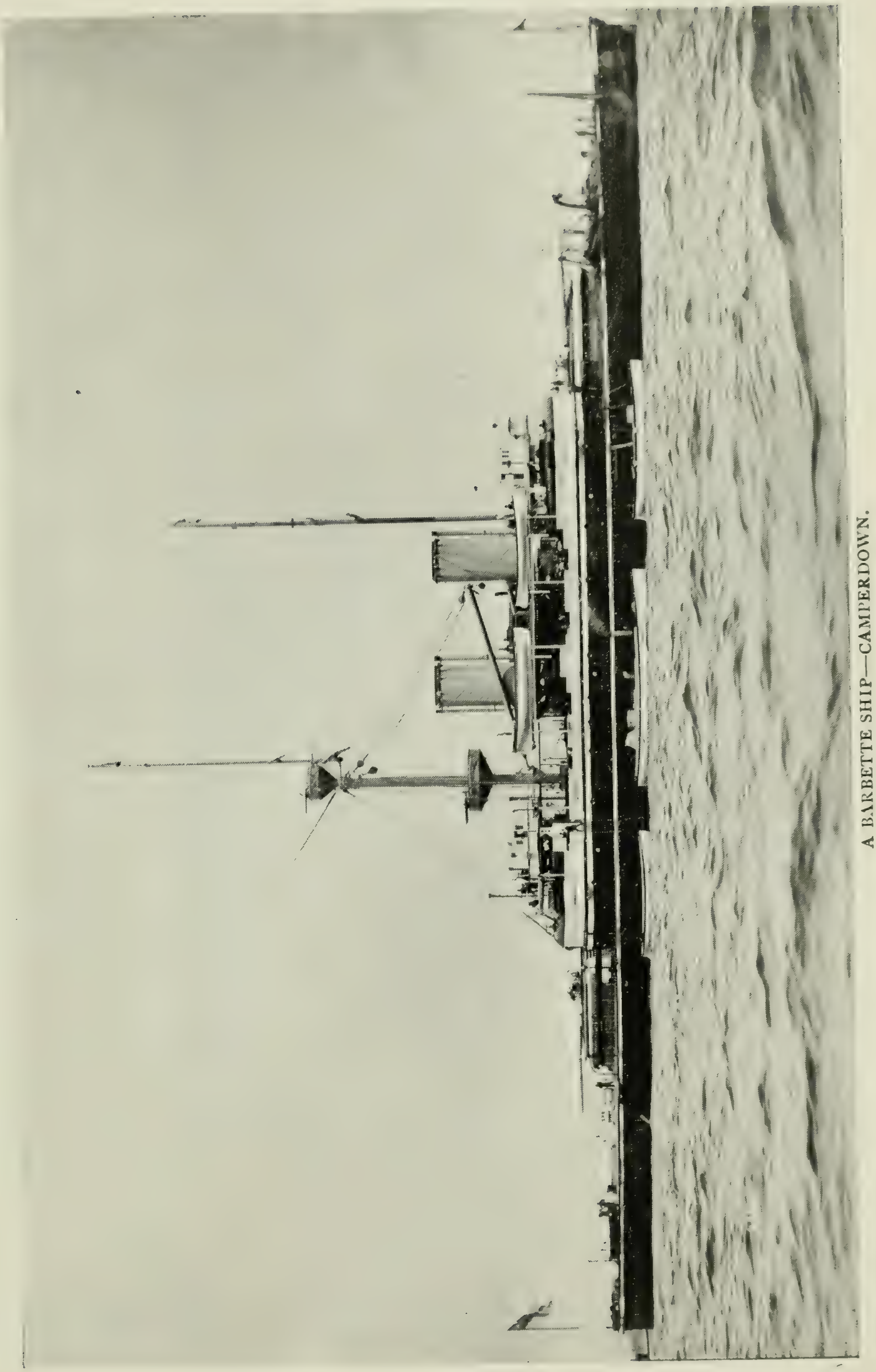
she should be fitted with masts and sails. The characteristic features of the Devastation were the low freeboard and the two turrets on the center line of the hull. In order to protect the base of the turrets, they were enclosed in an armored breastwork, or citadel, which did not, however, extend across the vessel, a space being left between it and the ship's side. The armor extend edall of the way around, and was 12 in. thick amidships, tapering to 10 in. at the bow and stern, while that of the turrets is 14 in. The Devastation carries two 35-ton guns in each turret. Though the general opinion of the navies of the world has inclined toward the double turret, especially in vessels of large dimensions, yet in two later iron-clads, the ill-fated Victoria and the Sanspareil of 10,500 tons, there was a single turret forward protected by 18 in. of compound armor, and carrying two 110-ton guns. In order to compensate for the loss of stern fire entailed by a single forward turret, these vessels were armed with a 29-ton gun mounted aft behind a barbette shield.

In the Benbow of 10,600 tons a 110-ton gun is mounted upon each side in a pear-shaped barbette 60 ft. long and 45 ft. wide protected by steel-faced armor 14 in. thick.

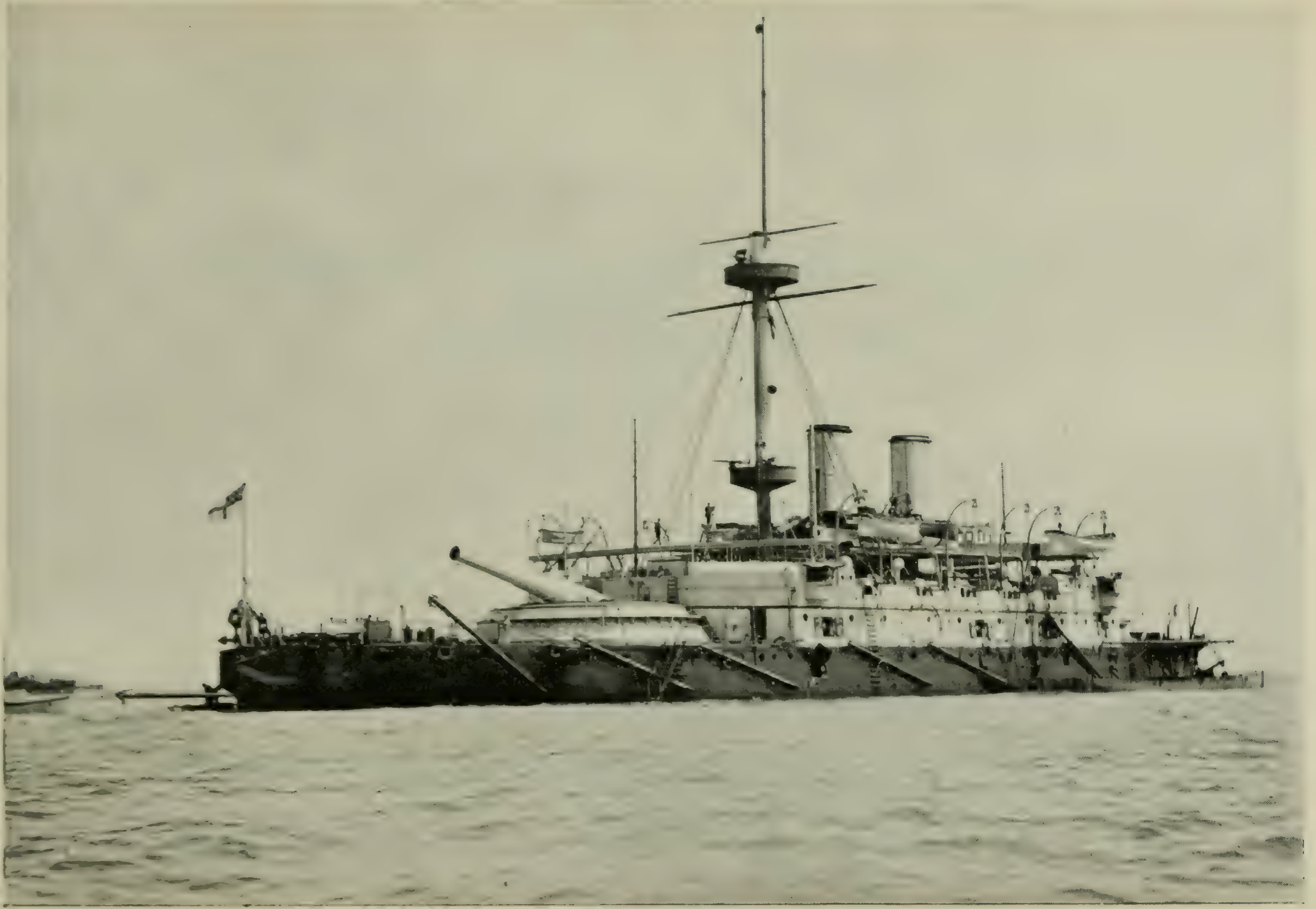
The Magnificent also mounts her heavy guns, four 12-in. breech-



A TURRET SHIP—H. M. S. VICTORIA.



A BARBETTE SHIP—CAMPERDOWN.



H. M. S. BENBOW.

Showing heavy guns mounted in barbette.

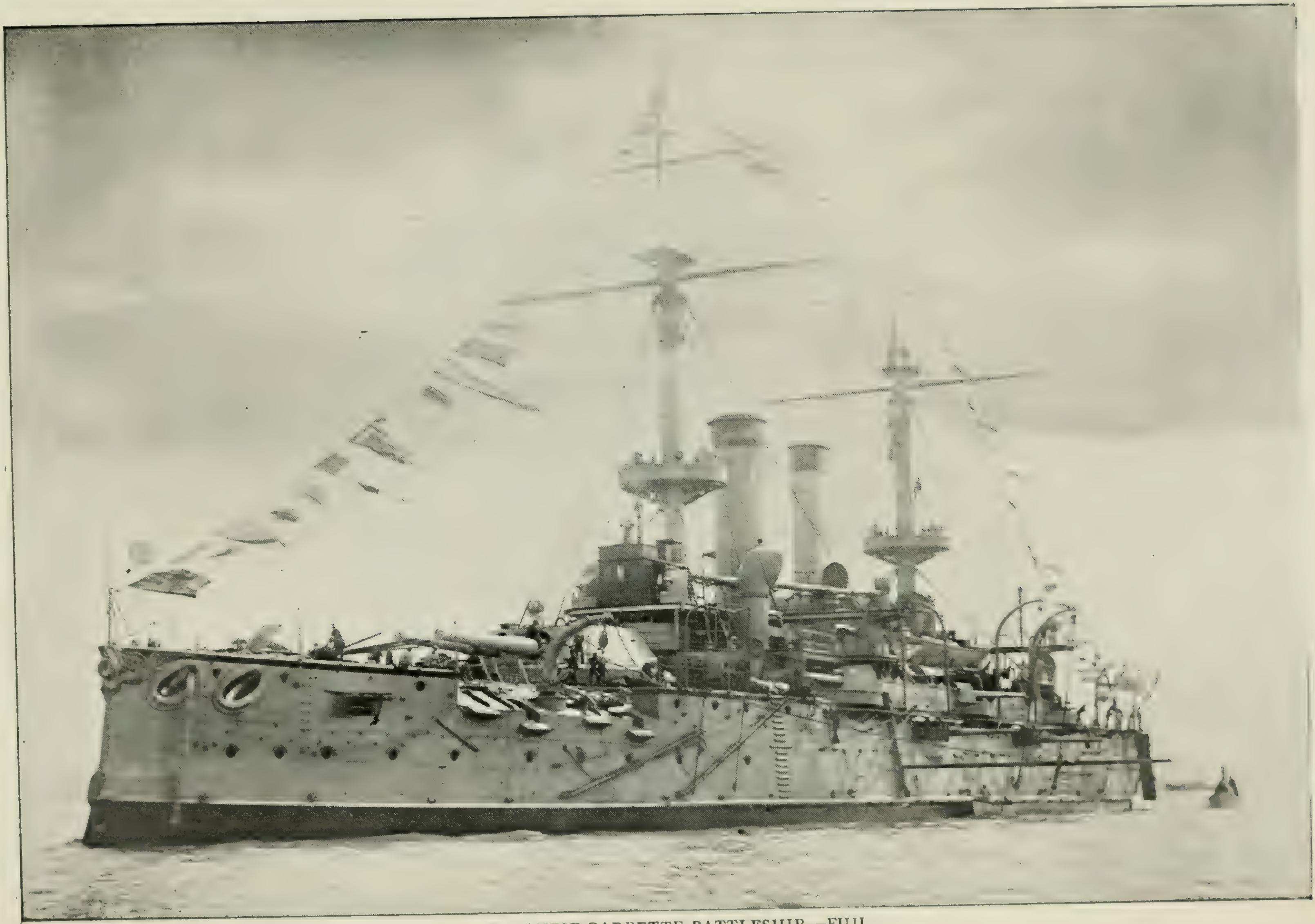
H. M. S. MAGNIFICENT. TYPE OF AN IMPORTANT CLASS IN THE BRITISH NAVY.

loaders, in two strong barbettes. These guns can be loaded in any position, and are protected by a strong armored shield mounted on the turn-table and moving with the guns.

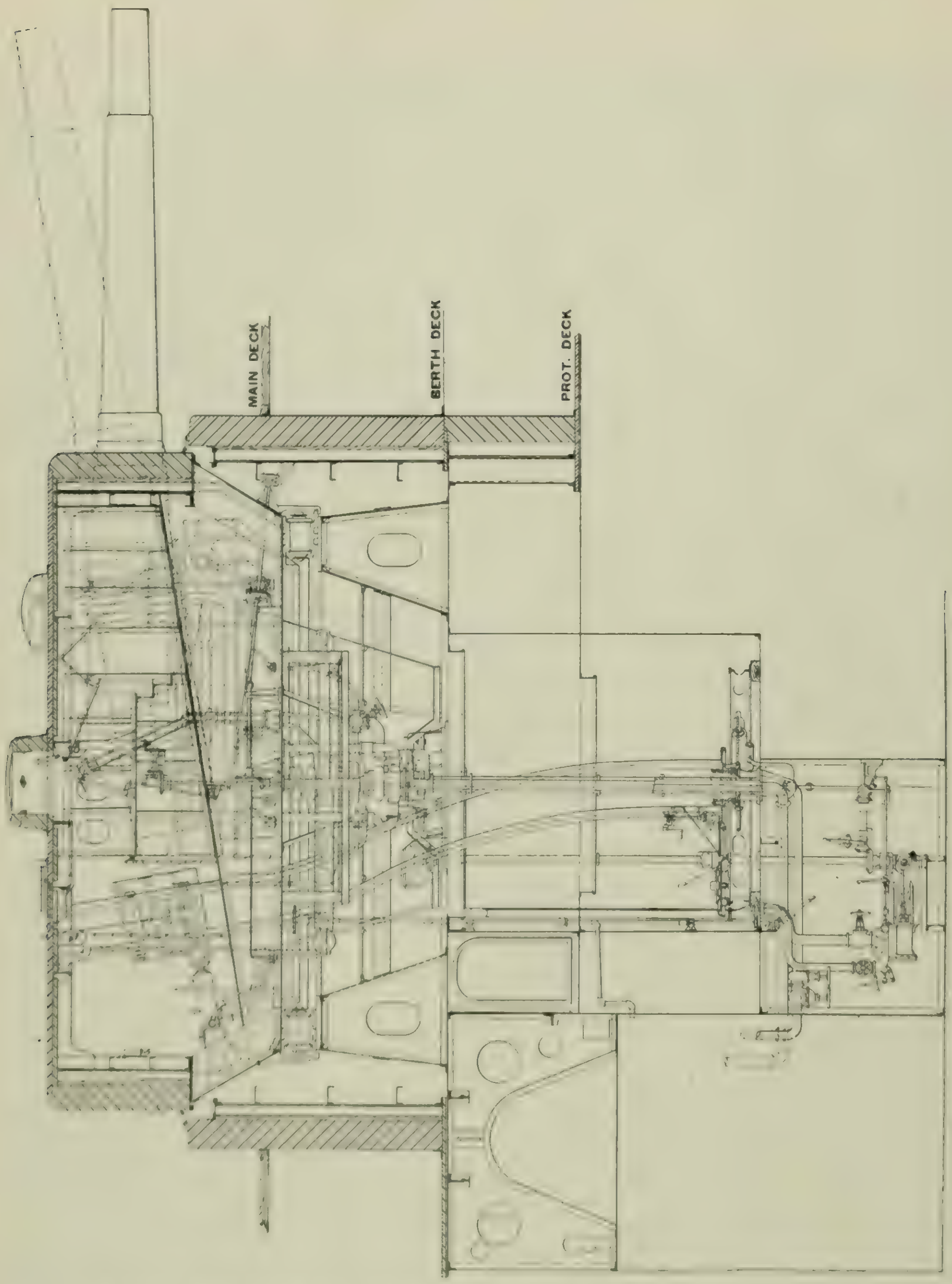
This development of the turret and barbette in the English navy was naturally imitated by the other nations of the world, who followed in the footsteps of the great sea-power, even when their vessels were built at home. Thus Spain in the Maria Teresa and Viscaya built on English plans, though constructing the vessels in her own yards. They have a flush upper deck without bulwarks, and a breastwork within which the 6-in. quick-firing guns are mounted. Within the extremities of the belts are the two barbettes, one at each end, and these are built of compound armor 10 in. thick. The barbettes are of circular section, and stand about 6 ft. above the upper deck, and have a strong protected roof-plate 4 in. thick. Each barbette contains a 28-cm. breech-loading gun, the gear for turning the gun and hoisting the ammunition being below the protective deck. The turn-table itself is constructed of steel plates and angles, and is supported on cast-steel rollers travelling upon a cast-steel roller path at the level of the deck.

Of all the modern navies, however, that of Japan has alone stood

A SPANISH BARBETTE CRUISER—VISCAYA.



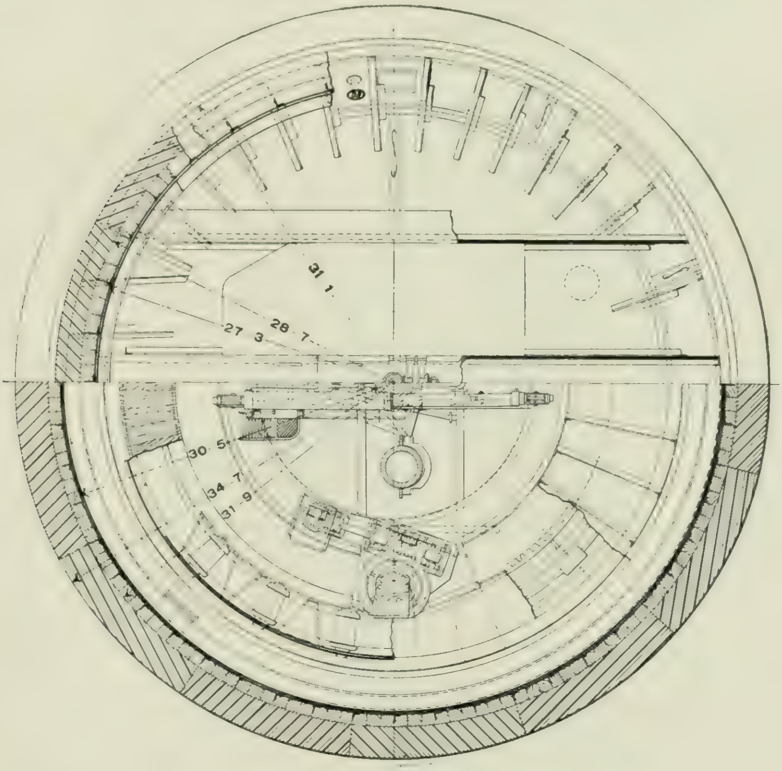
A JAPANESE BARBETTE BATTLESHIP—FUJI.



VERTICAL SECTION OF TURRET OF THE U. S. BATTLESHIP INDIANA.

the test of an enemy's fire, so that a word regarding one of her great ships may not be out of place. The Fuji is an English-built ship, and, with her high free-board, her two military masts, and four 12-in. guns mounted in two pear-shaped barbettes, bears a strong resemblance to H. M. S. Magnificent. These barbettes are connected to the side armor by heavy armored screens, the maximum thickness of the barbette armor and that of the conning tower being 14 in. The vessel has a total length of 400 ft., a width of 73 ft., a draft of 26 ft. 6 in., and a tonnage of 12,450, and is propelled by twin screws driven by engines developing 13,500 horse power, and capable of developing a speed of 18¼ knots.

Returning now to the United States, we know of the absolute cessation of all naval construction for many years after the civil war; how the navy was allowed to deteriorate until the ships in commission were incapable of sustaining the shock of a single shot from any of the vessels owned by England, France, or Italy. Then came the renewal of activity, resulting in the construction of vessels that stand in the front rank in design and probable efficiency. Naturally the turret has been developed, and we shall see that the American navy department is responsible for an innovation almost as radical as that of the original introduction of the turret itself.



HORIZONTAL SECTION OF TURRET OF U. S. BATTLESHIP INDIANA.

The Indiana is one of the later additions to the navy, and carries two turrets in barbette, each mounting two 13-in. guns. The vertical and horizontal sections of one of these turrets shows the construction very clearly. From these it will be seen that there is a circular barbette formed of armor plate 17 in. thick and extending from the berth deck to a height of 3 ft. 6 in. above the main deck and presenting the external appearance given in the half-tone reproduction of the photograph of the after-deck. The turret of 15-in. armor is 31 ft. 1 in. outside diameter, and rises 6 ft. 8 in. above the top of the barbette. It is carried by strong brackets that slope down and in towards the center, forming a ring that rests upon conical rollers travelling over a circular track that is, in turn, supported by brackets rising from the level of the berth deck. The engines and turning gear are located at the bottom of the barbette, below the main deck and well out of danger from the enemy's fire, while the machinery for operating the ammunition hoists is placed still lower, and is far below the protective deck.

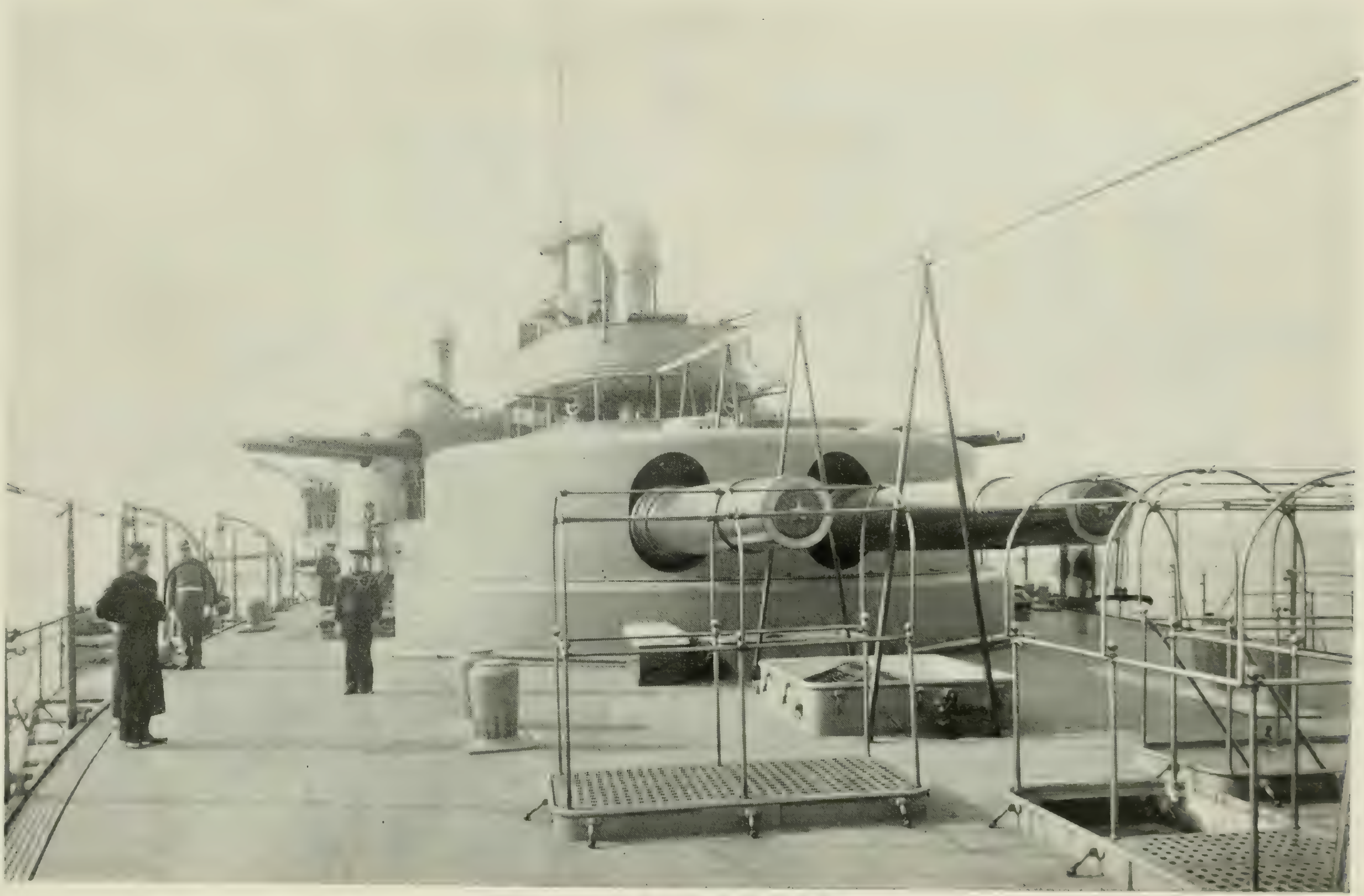
This may be taken as typical of the construction of turret that seems to be most favored by the United States navy, though it has vessels with turrets and no barbette, while on some the guns are mounted behind a protective shield only.

The innovation that is to be made is in the new double-turreted battleships, one of which is to be named the Kearsarge. They are still in course of construction, and their salient feature consists in the location of one turret directly over the other. No photographs of this construction are, as yet, available, but the drawings, kindly furnished by the bureau of construction, show the arrangement more clearly than would be possible by photography.

The two turrets are fixed together so that they necessarily revolve in unison. They differ, too, in plan, from all that we have, thus far, considered in that they are elliptical, though, of course, they must revolve upon a circular track. The upper turret is formed of armor plate 11 in. thick upon the fighting side and 9 in. at the rear, while that of the lower turret is 17 in. and 15 in. respectively.

The major axes of the turrets on the outside are 19 ft. and 32 ft. 3 in., with minor axes of 16 ft. 6 in. and 26 ft. From the armor deck to a height of 2 ft. above the main deck there will rise a citadel 15 in. thick on the front face and 12½ in. at the rear. This is circular, and will serve to protect the track upon which the turrets travel as well as the racks and turning gear, which are located below the lower edge of the turret, as in the Indiana.

As in every new device, opinions differ as to the advisability and practicability of the new design. When the "Monitor" was built, the scoffers were loud in their ridicule, and strenuous were the assertions that the men in the turret would be injured by the concussion of the gun; and the same fear has been expressed regarding the effect of the firing of the upper guns upon those in the lower turret. It is, however, merely a surmise, and there is no precedent to lead one to think that such would be the case, for the discharge of guns from ordi-



AFTER DECK U. S. BATTLESHIP INDIANA.
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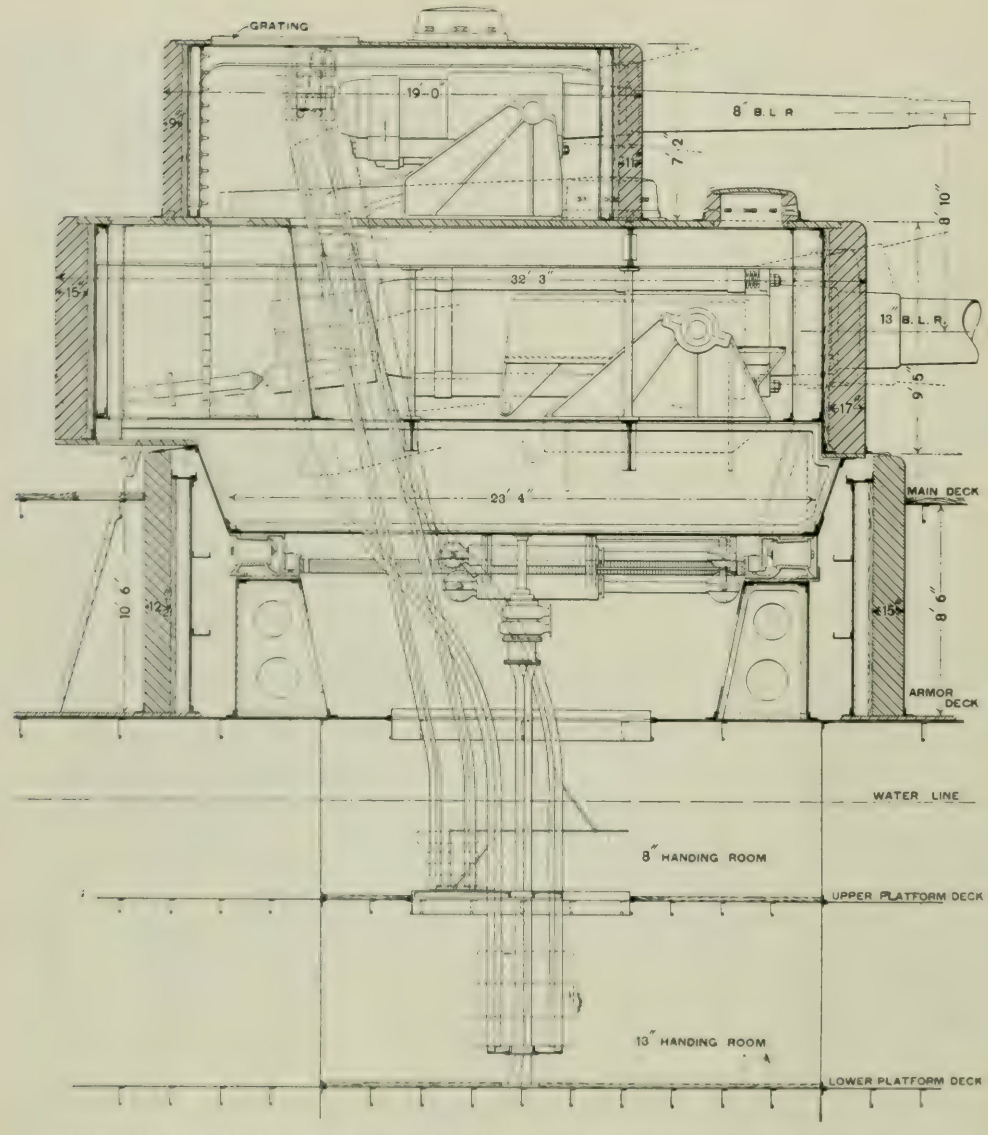
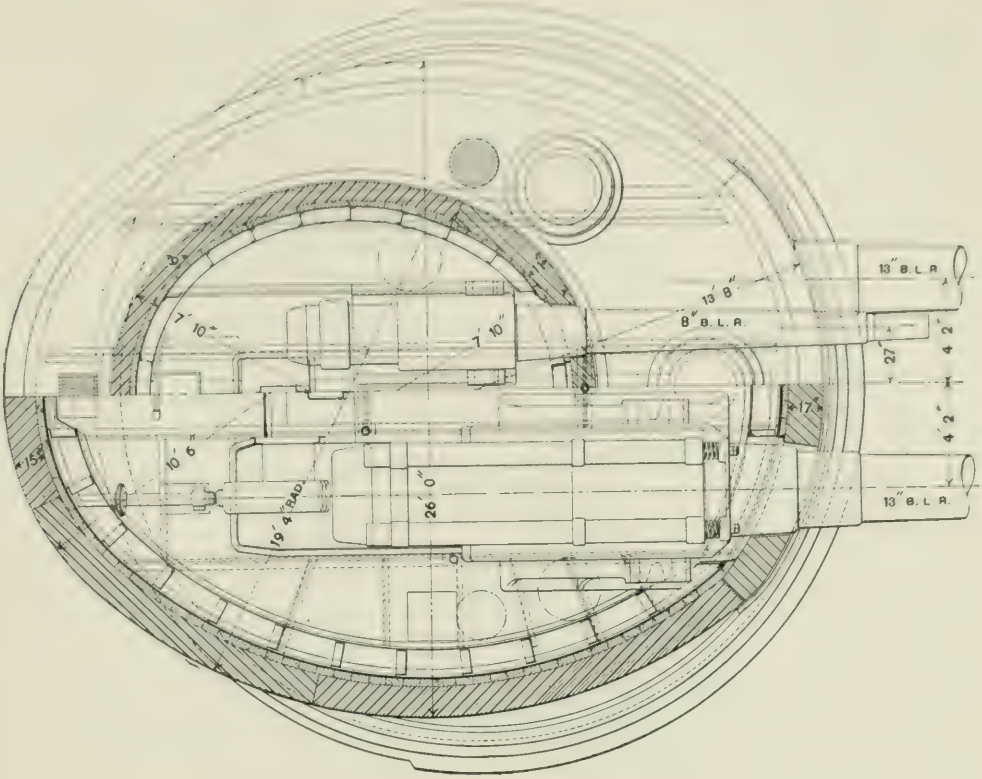


VERTICAL SECTION OF THE DOUBLE ELLIPTICAL TURRET OF THE KEARSARGE.

nary turrets has never been known to do any injury to men between decks.

It should be borne in mind, however, that we have as yet but a very meager record of what effect the firing of one of the heavy guns across the deck would have. In practice they are fired abeam, possibly for the very reason that there is fear of the effect on deck. Certainly the experiment would be worth the trial, even to the extent of causing a sudden and splintering removal of the planking from the quarter deck. We do know, however, from the experiments at Indian Head, that the crushing effect of a discharge is very great upon any surface immediately below the muzzle.



HORIZONTAL SECTION OF DOUBLE ELLIPTICAL TURRET OF THE KEARSARGE.

Thus the turret has grown from the single "cheese box on a raft," to be the typical and main means of defence for the large guns in all of the navies of the world; but, just as it has reached the maximum of its strength and its guns have risen to unheard-of diameters, throwing costly projectiles through a trajectory of many miles, discussion is rife as to whether or no it is the best method of construction, involving, as it does, comparatively low speeds,—speeds too low to make them available as commerce-destroyers. It is the torpedo boat that is now advocated for offence and defence, and its advocates claim that, as the little kingbird, by its rapidity of movement, can drive the hawk or the crow before it, so a swarm of these fleet little craft would soon whip the greatest battleship of the world. The fact is that in the original idea as conceived by Ericsson there was probably no intention that the turret would ultimately become *the* means of gun-protection; certainly he could have had no idea of the growth that ordnance would attain, since at that time a 11-in. columbiad using fifteen pounds of powder was the heaviest gun available. This increase of ordnance is, however, probably a direct result of the increase in the thickness of armor plate, for the struggle of the one has always been to throw a shot that would pierce the other, amounting at times to an almost amusing inconsistency, as when a navy board awards a contract for armor plate that shall be guaranteed to withstand the impact of a projectile the strongest yet known, and then immediately asks the same contractors to furnish a better projectile to pierce their own armor. The increase in the size of the ships, with the necessary raising of the turrets high above the water-line, have tended to a decrease in the stability of ships that in a few instances has necessitated a practical reconstruction, until it seems as though the limit has about been reached, which may perhaps be one of the reasons why the turret has not yet convinced the naval world that it is the fittest to survive; probably nothing but a great war can settle the question as to whether it is better to depend upon strength or speed. We may well ask the question, which shall it be?

REVIEW OF THE ENGINEERING PRESS

The Future of Marine Engineering.

In the September number of this magazine, Lieut. Ridgely Hunt presented an exceedingly interesting account of progress in marine engineering during the last fifty years. Others are forecasting what may be expected in the future. It is not probable that we are near the end of the splendid line of advance portrayed by Lieut. Hunt, and *The Iron Age* (August 5) devotes a couple of columns to a prognostication of what it considers the probable future of naval practice. It might be thought by those unfamiliar with marine engineering that the great navies of the world and the merchant shipping interests are distinct, and ought to be considered separately; the contrary is the correct view. The military marine and the merchant marine are interdependent. Many of the existing English steamers now devoted to peaceful commerce were specially constructed for use as war vessels, if occasion should require. The practice in steam engineering on merchant ships and on war vessels increases every year in similarity. Improvements first introduced and used in the merchant marine have been adopted in the military marine, and *vice versa*. In all places where the British government has developed an important commerce, as in the Argentine Republic, the facilities provided for accommodating her merchant vessels are accompanied with facilities for coaling, docking, and repairing the war vessels with which she guards her merchant marine in all parts of the world. So much for the intimate relation between the military marine and the merchant marine. *The Iron Age*, in reviewing the tendencies of the present time in their probable effect upon future practice, appears to think it doubtful that steam jacketing will be continued. As to the piston-valve, it considers it possible that it may be superseded by the Corliss valve, as the conditions which formerly interfered with the use of a rocking valve have considerably changed. Water-tube boilers, it is thought, will, in the end, be generally adopted for war-vessels, and the reasons for this opinion are stated; they are the admitted advantages of water-tube boilers, which our contemporary believes sufficient to more than compensate for the also admitted disadvantages, for marine use, which this class of boilers has hitherto presented. The survival of one or the other systems of forced draft—to wit, the air-tight fire-room and the close-ash-pit system—is yet indeterminate, but forced draft of some kind is a probable feature of future marine engineering. "The ventilation of a ship is a very important problem. The most successful installations for war-ship ventilation provide numerous branch pipes on both the exhaust and the supply service, the one preventing the accumulation of hot, stale air, and the other insuring a supply of fresh air. It is very necessary, where men are working in a confined space below decks, to provide a proper current of air. In the ventilation of residences, school-rooms, and office-buildings drafts are studiously avoided by the engineer, but in a hot, confined space, where steam machinery is in operation, unless a blast of air is playing upon the perspiring bodies of the men on duty, there is but little benefit derived. The free perspiration which is always experienced in such situations insures the men against taking cold. It is not enough, when considering the ventilation of a space on board ship, to take cognizance of the temperature alone. The precise nature of the atmosphere is not well known, in spite of recent discoveries of new elements therein, but experience has demonstrated that a liberal supply of fresh air is necessary, if the body is to be kept in full vigor. . . . A ventilating problem yet to be solved is encountered in foggy weather. In this case the air is not only saturated with moisture of evaporation, but contains tiny globules of moisture in suspension. No matter how vigorously the blowers are run in damp weather, the evaporation of bodily moisture is too insignificant to keep the men below deck cool and comfortable, and their efficiency is, of course, very much impaired while such weather lasts. It is much to be wished that some practicable device for separating the moisture may be invented. A scheme that has been proposed, and even tried with some success, is that of heating up the incoming air so as to increase its capacity for moisture; but, although this scheme is not so unworthy as it might appear, yet it does not afford the desired solution." It is maintained that a degree of efficiency and economy in the working force of the navy comparable to that secured in the working force of a large factory has not been obtained, and that, from the nature of the case, it is quite impossible to attain to such efficiency. Nevertheless, it is believed that a considerable advance in this respect could be made through the application of common-sense methods. "In the first place, the naval service ought to be of such a character as to attract to itself the very flower of our young manhood. The recruiting office should be able to state truthfully to its applicants that the navy offers a career that any young workingman may be glad to take up. Good pay, kind treatment, healthful surroundings, occasional shore duty, a neat and attractive uniform, and a reasonable amount of recreation,—these are some of the requirements that a young man of character, health, and skill may reasonably insist upon before affixing his name to three years' enlistment papers."

Western Mill Construction Defective.

With reference to safeguards against fire in the construction of western mills, particularly chlorination and cyanid mills, *The Engineering and Mining Journal* (July 17), in an article on "Precautions Against Fire in Metallurgical Works," criticises the construction of this class of buildings, and pays a high tribute to the system of slow-burning mill construction developed in the New England States, which it recommends to the consideration of western mill-owners. Even with such construction, it is doubtful whether gold and silver mills will ever get the low rates of insurance allowed to mills in more thickly populated regions, where facilities for extinguishing fires are greater, and where "the moral hazard" is not so great. Most western mills are said to be constructed of timber, and many of them have timber roofs, although corrugated iron is often used for roofing. "The roof is sometimes supported by trusses, leaving clear working-rooms; but, more frequently, it is borne on posts stiffened with angle-braces and cross-beams, the whole forming a forest of timber, which not only obstructs the light and access to the machines, but adds a good deal of inflammable matter to the structure. . . . Little attention is paid to regularity, and breaks are made in the roof, cupolas for elevators are stuck on, and gables are obtruded wherever necessity dictates, the result being a multiplication of dark, more or less inaccessible cock lofts, in which combustible matter may accumulate." Such accumulations are easily ignited by the careless use of a match or a pipe, and usually total destruction is the result of a fire in such a building. The drying and roasting furnaces, especially when erected on hillsides, in cramped situations, are a prolific source of conflagration. The Rosebud mill fire at Cripple Creek was caused by such a furnace. Great carelessness in allowing wood in close proximity to furnaces, and sometimes even in contact with them, exists. An instance of the ignition of a wood partition, abutting against the walls of an assay furnace eighteen inches thick, is cited as an evidence of this carelessness and the danger attending it. Among precautions against fires in such mills watchfulness and the prevention of combustible accumulations in unused or little-used places rank first.

The Limits of Regulation for Water-Power Plants.

It has been found impossible to regulate the speed of any kind of motor instantaneously with and proportionally to changes in the amount of work it is required to perform. The change in the load must be first initiated, and the regulation of the speed must follow. There must, therefore, be an interval of time between the beginning of change in load and the beginning of the regulation, and one of the things to be aimed at in the construction of an efficient governor is the reduction of this time interval to the lowest possible limit. Now, while changes in velocity bear a strict relation to the force in action, and, with a given force, require a definite time for their accomplishment, a change of load may be instantaneous. The problem of making a good governor therefore involves the correlation of sudden changes of load with gradual changes in velocity, and in such manner that the former shall control the latter. But, as the one must occur before the other, some change in velocity cannot be avoided. Delicacy of action in a governor, therefore, involves not only the reduction of the interval between change of load and the beginning of the control, but also the power to prevent a wide change of velocity during a subsequent short interval. Mr. Mark A. Replogle, in *American Machinist* (Aug. 19), says that "the regulation of the speed of a water wheel in a power plant is determined by four distinct factors, to wit, (*a*) changes in load or requirements of power; (*b*) time for gravity to generate power; (*c*) capacity of the plant for stored energy; and (*d*) the governor mechanism that should automatically combine the above three factors in such a manner as to obtain even speed or good regulation." He then proceeds to show that the speed of a plant is the resultant of the force which drives it and the force which opposes its motion. When either of these forces varies, the speed will vary, unless the other force is proportionately and simultaneously varied. We have seen that simultaneity is out of the question. It follows that any change in the driving power or in the load must result in some change of speed. The lowest possible limit of this change may be said to be reached when the capacity for storage of energy is infinite; but this is, of course, a theoretical limit, entirely impracticable in engineering practice. Its consideration, however, leads to the principle that, the larger the capacity for storing energy can be made, proportionately to the possible changes in load, the more perfect will be the regulation. This is the well-known principle upon which a fly-wheel acts to prevent sudden wide fluctuations in speed, when sudden changes in load occur; but a fly-wheel, while it prevents sudden changes in speed, will not prevent gradual increase of velocity. Now, Mr. Replogle shows that the time element in water-power regulation is more important than in steam-engine regulation, owing to the nature of the moving mass (water-column) from which the power is derived. Water being practically inelastic, if confined in a pipe or flume, the force required for the stoppage of the motion of the mass will be a function of the length of the pipe or flume. He therefore advises that, where refined regulation is desired, long horizontal pipes should be avoided, and that the power-supply should all be under the direct action of gravity, and move in a line with it.

Roasting Previous to Cyaniding.

WHILE the idea has been prevalent that treatment of ores with potassium cyanid does not require previous roasting, Mr. Wallace Macgregor, in *The Engineering and Mining Journal* (August 14), says truly that a higher percentage of gold is obtainable by calcination. He also asserts that in many cases the increase of yield through roasting prior to cyaniding has been so important that the method has come to be recognized as having passed the experimental stage. The method is most applicable to ores composed of veins of quartz or other rock with gold-bearing iron pyrites distributed through it. "The important changes brought about are, first, keeping the cyanid solution freer from soluble salts than when raw ores are treated; second, making a very high percentage of gold in sulphid ores easily extracted by cyanid solution in subsequent treatment; third, an equal or less consumption of cyanid, with a greater extraction of gold over that obtained on raw ore; fourth, the ability to treat low-grade, silicious ores, carrying the gold value in iron pyrites, without previous concentration; fifth, causing clayey ores to lose the water of hydration, and thereby rendering them porous and making the filtration of the solution much more rapid." Mr. Macgregor cautions those who wish to experiment upon roasting and cyaniding that "they must obtain dead roasted ore before attempting to extract the gold," and adds that "those starting with laboratory experiments will soon find that, by roasting with a very low heat, and a short time in a muffle, they can extract a very high percentage of gold, but that they are doing so at the expense of the cyanid." The importance of dead-roasted ore is insisted upon. Operating with partially-roasted sulphid ore is working under the most wasteful conditions, and the chemical reasons why this is so are very clearly set forth at length. A quick and satisfactory method of testing whether the ore is dead roasted or not is as follows: "Take samples of the roasted ore at the discharge end of the furnace, cool, take from 100 to 150 g., place in a beaker with some 200 c.c. of water, stir this by shaking for about a minute, then filter into a beaker flask, and to the filtrate add a small quantity of cyanid solution, made up to the same strength as that used in the regular work of the plant. It is best to add the cyanid solution slowly and carefully, noting the result. If no cloudiness at all appears, the ore is dead roasted, or at least well fitted for treatment by cyanid solution, and the consumption of cyanid will be normal. If a brown coloration takes place, there are still some soluble salts of iron left in the ore, which will cause a somewhat higher consumption of cyanid, and may lead to a precipitation of compounds of ferro-cyanid in the zinc bottles. If, on addition of cyanid to the filtrate, a blue colorization, soon becoming a greenish blue precipitate, is formed, then the ore is very badly roasted, and one may look for a high consumption of cyanid, and the circulating solution will be made foul." It is also indicated that the economy of the process depends upon conditions varying with different ores, and that, therefore, no general determination of this point can be made. It is admitted that there are ores of so low a grade that roasting them would not pay, the cyaniding of which may, nevertheless, pay a fair profit. It is also admitted that roasting is not an economical process with heavy sulphureted ores and concentrates. In conclusion, it is recommended that laboratory tests for determining the advisability of roasting should be supplemented by small plant tests with from one to ten tons of dead-roasted ore.

Oil-Coated Ballast.

ONE of the innovations in railroading now on trial has been made the subject of experiment on the West Jersey and Seashore division of the Pennsylvania railroad system. This innovation (patented by Mr. James H. Nichol) consists in the application of heavy mineral oil of low cost to the roadbed of a railway, including sides and slopes, the object being to prevent the rising of dust therefrom during the passage of trains. A sticky material used for such a purpose must be insoluble in water; otherwise it will leach away and its supply will be expensive. The inventor, in a letter to *The Railway Age* (August 6), sets forth the purposes of the invention as follows: "Probably from the first building of railroads, gravel, such as is found along the lines of the roads, has been used for ballast, and, if of proper nature, porous and free from clay or loam, so as not to retain water, it is one of the best substances yet used; track laid on such a foundation is elastic, therefore making the riding in cars comfortable, as compared with the more rigid stone ballast. This same elasticity is a benefit to the ties, and particularly to the rails, the latter, when placed on a rigid support, being in the position of a piece of metal between an anvil and a hammer, the hammer being the moving train. Track laid on gravel ballast is more quickly and cheaply repaired than when on stone, the cost of ordinary maintenance and for labor in renewal of ties being about one-half. The principal reason for the discarding of gravel ballast on many railroads has been the discomfort to passengers arising from dust. As substitutes various materials have been used, such as cinders from anthracite and bituminous coal, burnt clay, crushed stone, etc. Each of these substances has some dust connected with its use, stone having the least. Cinder ballast is thought by some to affect injuriously the life of the cross-ties, rotting the wood with which it comes in contact. Stone ballast, when first applied, and after being washed by rains, is clean and free from dust, until such time as it becomes filled with material,—largely cinders thrown from the stacks of freight trains,—and in this condition requires to be forked out and cleaned at large expense; the tamping of the ties, to obtain and preserve a level surface of the rails, results in the stone being crushed under the ties; and, if of a limestone character, a condition resembling a cement trough is formed under each cross-tie, which catches and retains rain-water, causing the tie to decay. Cinder ballast, after being newly applied, requires several rainstorms to wash it free from dust, and then it is reasonably clean, until the work of surfacing the track, or renewing cross-ties, stirs up the cinder from below the surface and exposes a new layer of dust. After a few years' use, cinder becomes pulverized by repeated tampings, and is then a more objectionable dust than that from gravel, being dark in color. Experience shows that the oil produces equally good results with cinder as with gravel or sand." Two thousand gallons of oil per mile are used. The distribution is effected by special apparatus illustrated and described in the journal quoted.

New Method of Constructing Dynamos.

MR. ALBERT W. SMITH, in *The Electrical Engineer* (Aug. 12), describes and illustrates a new method of dynamo-construction, and sets forth his reasons for supposing this new construction to be an advance upon hitherto-existing designs for dynamos. He proposes the rearward displacement of the field magnet coils "from the neutral or commutating points," and winding them "in or across the flux paths of their respective magnets and close to the armature." By these changes he expects to obviate "the employment of large field coils, which impose the necessity of long magnet cores, which in turn imposes a large and heavy yoke structure." He argues the case as follows: "It is obvious that the magnetism generated by any given term or section of a field coil must pass through that turn or section, though it need not pass through all the turns or sections of the coil, but may leak out through the side of the coil adjacent to its own turn or section; it follows, therefore, that the magnetism generated by a field coil cannot be shifted forward further than the width of the coil. It is, then, only necessary to wind the coils entirely back of the neutral lines, and as close to the armature as practicable, to insure the desired freedom from field distortion; this is made possible by using a field magnet structure which has on one side of its neutral points a single wide pole, or polar area, and on the other side thereof a plurality of smaller poles, forming between them coil-containing spaces (or, instead of plural poles, a single large coil space), in which space or spaces the coils are wound." The diagram which accompanies the article under review makes the above statement clearer, but we think electricians will understand it without such aid. "By this method of winding the field coils, a long external air-path of very great reluctance is opposed to the armature magneto-motive forces, thus obviating the present necessity for a large air-gap reluctance; the size of the air-gap is, therefore, imposed entirely by the mechanical conditions, and can be made very small, while the core teeth can also have the same low reluctance as other parts of the magnetic circuit. The magnets, consequently requiring only a small fraction of the magnetizing energy now necessary, and the coils being correspondingly smaller, consequently require proportionately less winding space; thus insuring a field magnet structure which has about the same weight as the armature, or somewhat less." Another innovation proposed by Mr. Smith is intended to obviate the present method of commuting under the leading pole corners, in which method it is necessary to provide for adjustment of the brushes, and to use carbon brushes, which cause a waste of energy. Mr. Smith proposes to entirely prevent the self-induction caused by the spark, " by interlinking the coils at the moment when their segments leave the brushes." He thus aims to oppose to the magneto-motive forces, due to current increase, counter magneto-motive forces, which, being equal or superior in strength to the former, " will suppress those due to the armature coils, and thus absolutely prevent the existence of any spark causing self-induction in the commutable coils, thus insuring sparkless commutation, and enabling the use of metal brushes, which may be either solid, laminated, or of gauze construction, and which remain in a fixed position for all variations of load and speed." We can not deal further with this suggestive article. We do not understand that the proposed innovations have yet been carried out in a practical machine. Till this is done it will be too early to estimate the value of the changes proposed.

The Coffer-Dam Process for Piers.

UNDER the above title Mr. Charles Evan Fowler, in *Stone* for August, commences a discussion of the use of coffer dams in the construction of piers, tracing the methods of constructing bridges from their earliest employment up to the present time, and classifying the different kinds of bridge-foundation construction. He thinks that there are four general classes of construction, and that a fifth may be added. First there is " the method with open caissons; second, the use of piles with a capping of coarse concrete about the top; third, the use of piles after the manner of the French *encaissement*; and, fourth, the use of the coffer dam. A fifth method might be added, in which the bridge is built on dry land adjacent to the stream, and the river diverted to a new channel afterwards excavated under the new structure. This is, however, rather an avoidance than a solution, unless the river is to be diverted in the course of improvements." We cannot recall any instance of the employment of the latter method on a scale sufficient to render such construction of historical importance. The method has, however, been used to a very limited extent in railway construction, principally in culvert construction, and a culvert might possibly be defined as a bridge over a small stream. If any notable example of the employment of the method exists, Mr. Fowler does not cite it. He states defects of earlier methods which led to the employment of coffer dams. Until this device was invented, a careful examination and inspection of the bottom on which the foundation was to be placed was impossible. The use of coffer dams having fallen into disfavor since the advent of the pneumatic caisson, the author endeavors to trace the causes of this disfavor, and to prove, by the citation of successful examples of the use of coffer dams, that this prejudice is in great measure unfounded. One reason why the coffer dam has sometimes proved unsatisfactory is the fact that the specifications leave too much to the judgment and integrity of the contractor. As an example of complete and thorough specifications for coffer-dam construction, he cites those prepared by Robert Stevenson for the construction of coffer dams for the Hutcheson bridge over the Clyde at Glasgow. These specifications are quoted as a model of explicitness, and Mr. Fowler sees in the want of similar care in more modern specifications a reason why coffer dams have so often proved unsatisfactory. The subsequent parts of the series will give successful examples, and will deal with first essentials of construction and expedients for meeting accidental emergencies.

Competition for the New York Public Library.

THE hope that a building of so much importance as the proposed New York Public Library will be a worthy exponent of American architectural talent is probably shared with us by every lover of art. It will not be enough that the interior design affords every facility and convenience for library work, both as regards its administration and its usefulness to readers; its exterior design should rival in artistic merit any other building within the limits of Greater New York. The application of the competitive system to the securing of such a design, however, does not greatly encourage the hope above expressed, in view of the many previous failures to gain satisfactory results by this method. Yet, in this instance, it would be difficult to suggest any substitute mode of procedure that would equally content the American public. We say "American public," for it cannot be reasonably supposed that interest in this matter will be confined within the limits of the newly-consolidated city, notwithstanding that in the preliminary and final competitions which will be instituted the former will be limited to the practising architects of Greater New York. The conditions of this preliminary competition are set forth by "Jack Shingle, Architect," in *Architecture and Building* (Aug. 7). The first thing that will impress the thoughtful reader of these conditions is the smallness of the prize—$400—offered to each of the producers of the twelve best designs. The ridiculously small sum of of $4,800 dollars is thus shown to be thought sufficient to enlist the best efforts of twelve competent architects in this work. Of these only six can be selected for the final contest, and these must again compete with six others probably not selected from the first competitors. And even if the design of one of the original competitors should be chosen, he will not be able to reap the full glory and profit of the award, because the committee reserves the right to associate with him a consulting architect, who, whatever else he does, will share the fee of the successful designer. The reason assigned for the inclusion of six new competitors in the final competition is that the committee wishes to make sure that six leading architects will enter into the competition. The value of this last consideration is apparent enough, but the reasons for not including these leading architects in the preliminary competition are not so obvious. The author under review thinks that a reserve which will prevent an undue advantage to these new competitors will be difficult to maintain, and thinks a fairer way would have been to make the preliminary competition "simply a test of ability, and finish for a different site." As to the right to appoint a consulting architect, "Jack Shingle" presumes it will not be exercised, except a distinct necessity should exist for it. The exercise of this reserved right will introduce a marked and questionable innovation in architectural practice. It certainly is a contingency which cannot fail to handicap the competition, and may possibly deter from competing some who would otherwise submit designs.

Spontaneous Ignition of Coal.

THIS subject, of great importance to the coal-carrying trade and to marine underwriters, as well as to first-hand shippers of, and dealers in, coal, has received considerable attention of late. If all the conditions favoring the spontaneous combustion of coal are not fully determined, it is not the fault of the investigators who are seeking to make sure that no such condition eludes their pursuit. Among the latest presentations of the subject is a paper read by Mr. John L. Howard before the fifth annual meeting of the Pacific Gas Association, and printed in *American Gas Light Journal* (Aug. 9). While Mr. Howard thinks that the true cause of spontaneous combustion of coal has been discovered, the study of prevention and control has not, in his view, progressed very far. He traces the cause to the accumulations of fine coal directly under the hatches of vessels which occur during the process of loading. "In the process of loading ships with bituminous coal, . . . it will be found that, whether the coal be dropped from a chute or spout that overhangs the hatchways of the upper deck, or whether the coal be lowered through the hatchways and dropped in the hold with a minimum of fall, the forming pile will assume the shape of a cone. In this process there will be breakage dependent upon the friability of the coal and the amount of the fall. This breakage will be sensibly increased, if, in addition to the drop, the coal is allowed to go into the ship with the velocity due to the steep incline of the loading chute. There will be a shattering of lumps and a compacting of the mass because of the impact of blows from the falling body of coal. . . The fine coal resulting from this method of loading a ship lies in an inert mass where it falls, whereas the tendency of the lumps is to roll down the sides of the cone toward its outer edges." Having thus explained the manner in which these masses of fine coal are accumulated, it is next shown that after their formation they generally remain as formed throughout the voyage, always incurring the danger of, and frequently resulting in, spontaneous combustion, with loss of ship and cargo. Whether this combustion results from the chemical combination of atmospheric oxygen with the carbon, or with the sulphur of the coal, or with both, it is certain that, the larger the surface of any substance exposed to chemical reaction in proportion to its mass, the more active will be the reaction, and the more rapidly will the temperature be raised by the heat generated in the reaction. The finer a substance is pulverized, the greater will be the sum of its surfaces in proportion to its mass or weight. The combination of oxygen with the sulphur of the coal is the explanation of the spontaneous combustion of coal given by Berzelius, and is the more generally accepted explanation. In every pile of coal there exist two of the conditions that obtain in active furnaces. In the one case the combustion is made visible and intense through the greater rapidity with which the chemical action is made to occur after heat has been first applied; in the other the combustion is as surely taking place, though not apparent until the self-evolved heat reaches a point where the conditions are identical. The danger is not confined to bituminous coals, though these are more frequently the subjects of spontaneous combustion. Prof. Vivian B. Lewes holds the opinion that it is the reaction between the hydrocarbons and atmospheric oxygen that causes coals to heat; and perhaps this theory accounts for the fact that bituminous coals, being richer in hydrocarbons, are more liable to heat. If the plausible theory that spontaneous combustion originates in the finely-pulverized coal left in undisturbed masses in ships or in land-storage be the true one, the avoidance of such sources of danger does not seem difficult, though it might, in some measure, retard the rapidity with which vessels are now loaded with coal, and somewhat increase the cost of handling.

The Largest Hydro-Electrical Power Plant.

It is announced in *Electrical Review* (Aug. 4) that Messrs. Stewart & Company, owners of the St. Lawrence Power Company, have placed with a strong English syndicate bonds to the value of three million dollars, for developing what will be the largest power plant in the world at Massena, N. Y. The contracts for the construction have been placed, and the work has already been commenced, under the direction of Mr. John Bogart, of New York, chief engineer, and Messrs. Kincaid, Waller & Manville, of London, consulting engineers. The contracts placed are as follows: "Excavation of canal, building of power-house, intake and outlet construction, etc., with the Lehigh Construction Company of Bethlehem, Pa.; fifteen 5,000-h. p. generators with the Westinghouse Electric and Manufacturing Company, of Pittsburg, Pa.; fifteen 5,000-h. p. turbines, with the Stillwell-Bierce and Smith-Vaille Company of Dayton, Ohio. This enormous output of power has been, it is said, nearly all spoken for in advance, and will be taken within moderate distances of the generating plant. The favorable conditions for the establishment of a power-generating plant at Massena are probably unequalled in any part of the world. The detailed description of the entire plant, as now planned and in progress, is illustrated by a map, and the favorable physical conditions at this point are set forth.

THE BRITISH PRESS

Cottage Hospitals.

THE term contained in the above title will probably be new to most Americans. So far as we know, nothing exactly corresponding to the English cottage hospital exists in the United States. The movement for the institution of the cottage-hospital system does not appear to have been in the direction of economy, however much it may be approved from a humanitarian standpoint. The origin and the nature of the movement are set forth in a paper by Thos. W. Aldwinckle in *Journal of the Royal Institute of British Architects* for July, as follows: "The cottage hospital movement began, as many excellent things have done before, in a very small way; nor was hostile criticism or unfriendly indifference wanting. The late Mr. Albert Napper, of Cranleigh, was the author of the first work on the subject. But he was also, undoubtedly, the actual founder of the movement, for he established the first cottage hospital at Cranleigh, in Surrey, in the year 1859, by the conversion of an ordinary Surrey cottage into a hospital at a cost of about £50." The object was to extend to country districts the benefits of a hospital system. That this could be done very imperfectly at best seems obvious; but, even if great and numerous imperfections exist, there can be no doubt that many sick and indigent people can thus receive far better medical treatment and nursing than they could obtain through individual charity. The benefits which, it is claimed, these institutions render to society are that the cottage-hospital system provides against the evils of indiscriminate medical relief; it enables the patient to pay something, even when unable to pay the whole cost of medical treatment as ordinarily administered; each doctor is free to follow his patient into the hospital wards; and in these institutions the sick may obtain food, supervision, better hygienic conditions, and careful nursing. The system has received the general approval of medical men, and has thus, apparently, an assured future. Now, though books have been written upon the subject,—in fact, Mr. Aldwinckle's paper is in the nature of a review of a book,*—and, although many excellent plans for these small hospitals have been prepared and published, very little real advance seems to have been made in cottage-hospital architecture since the institution of the hospital at Cranleigh, which, Mr. Aldwinckle says, "remains a very good type of the small cottage hospital pure and simple." The building was a very old cottage of the Surrey type, given by the rector of the parish, and, as adapted to the purpose by the late Mr. Napper, provided for four beds on the first floor, the administration being on the ground floor. "The nursing is placed in the charge of a trained nurse under the supervision of a committee. Other small hospitals, since established, differ very little in details, except in size. They range from four to thirty-two beds in capacity. Some have a room for convalescents on the first floor." But a hospital containing thirty-two beds seems a development beyond what the term "cottage hospital" ought properly to include. It may be, as the United States becomes more thickly settled, and approaches conditions of living similar to those which obtain in thickly-populated agricultural districts of England, that the establishment of these small hospitals will become expedient here. Be this as it may, whoever shall write a comprehensive history of the hospital architecture of the nineteenth century will find in the English cottage-hospital the materials for an interesting chapter.

The New Docks at Buenos Ayres.

TRANSPORT (Aug. 6) quotes from the *Buenos Ayres Standard* a statement that the Buenos Ayres docks (claimed to be the largest, newest, and best equipped on the American continent) rank in importance with the federalization of Buenos

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*Cottage Hospitals. By H. C. Burdette. London, 1896. The Scientific Press, Limited, 428 Strand. Cloth, 10 *s* 6 *d*.

Ayres. The magnitude and importance of these harbor improvements may be inferred from their cost—£7,000,000 sterling. They are also said to have proved a financial success. Monte Video, on the opposite side of the river, now waits for some attempt to deal with the problem of accommodation for shipping. *Transport* says: "In order that each section of the Buenos Ayres works might prove dividend-earning as soon as completed, each basin or dock was designed so that it could be opened as soon as completed. The South Basin, covering thirty-five acres of water space, was opened in January, 1889; dock No. 1, in January, 1890; dock No. 2, in September, 1890; the third dock, in 1893; the fourth, in 1896; and the North Basin, in March last." The docks and their equipment were originally intended to cost £4,000,000, but additions to the original scheme increased the cost somewhat more than £3,000,000. "Numerous warehouses of enormous dimensions, all of which are crowded with goods and produce, have been erected; two graving docks, now the largest in South America, have been built for repairing warships and ordinary steamships; the hydraulic machinery has been increased, and many miles of additional railways laid. The cost of all these vast improvements is said to compare very favorably with the cost per acre of the docks at Liverpool, London, and Antwerp. Apart from the important impetus which the improved shipping and warehouse facilities have given to the general trade of the Argentine Republic, the docks, crowded as they already are, show at present a net return of nearly four per cent. on the outlay."

Dangers Connected with the Supply of Electricity.

A SUMMARY of a report of a committee appointed by the home office, after the inspection of twenty-six different generating stations and sub-stations, with the assistance of a number of experts, is printed in *The Architect & Contract Reporter* (August 6). The report states the existence of the dangers named in the following abstract. First, with the employment of accumulators, when the plates are overcharged, there may be generated an explosive gaseous mixture. Such a mixture is easily ignited from a spark or flame. It is, therefore, seen that care should be exercised not to overcharge the plates of a storage-battery, and that some caution should be used in approaching such batteries with an open flame. In electrical generating works there is danger of serious injury, or even death, from shocks caused by contact with conductors. This danger is great, provided any two parts of the human body are made to touch, even imperfectly, conducting materials differing in pressure by one thousand volts or more. A much less difference in voltage is dangerous, and may be fatal when there is full and perfect contact with the flesh. It is, however, noted "that, of fourteen fatal accidents which have occurred in England during the last five years, in not one case was the pressure below one thousand volts." The highly-charged metals, protection from contact with which should be provided, are in the dynamos, switchboards and their connections, high-pressure mains, transformers, and the lamps of series arc-lighting systems. "In the case of high-pressure alternators or dynamos it should be impossible for an attendant, whilst oiling the bearings or cleaning the frame, to make any contact with any live metal. Efficient guards should be arranged over the collectors or commutators, terminals, and leads, for this purpose." The committee does not recommend the use of oil-cans with insulating handles, and takes the position that, if all the live metal-work is well guarded and the frame earthed, an insulated oil-can is unnecessary. While the front of a switchboard should be easily and quickly accessible, the back should be accessible only to "skilled persons having the right and means of entry. This latter is a very necessary precaution, as it is often possible to touch live portions of metal and iron supports or stays which are practically earthed; and a person who is not fully aware of this danger should have no access to such places." The exposure of any live metal work on the front of a switchoard is entirely unnecessary. Overhead, igh-pressure, uninsulated conductors may ecome dangerous by breaking; or they ay cause danger by being brought into ontact with buildings through the action f winds. Even if wholly insulated, they re regarded as never free from risk. nderground conductors are considered omparatively safe, as the insulation reuired to prevent loss of current is, when erfect, always sufficient to protect from erious risk the person of any one coming contact with the insulating material. ut it is pointed out that in underground onductors a defect in insulation, scarcely ufficient to make its presence felt in orinary working, may allow "the escape of ufficient current to produce instantaneus death." With reference to arc lamps series it is said that, as these are in any cases placed so high that a ladder ust be employed to reach them, a shock, itself too light to cause serious injury, ay in such cases result disastrously by ausing the fall from the ladder of the erson so shocked. The following regutions for work at front or back of witchboards are recommended, under e assumption that the backs of all witchboards will be kept closed except or the purpose of alterations and repairs : (*a*) No person except a skilled electrician, r a workman under his personal and imediate supervision, shall be employed hen any part is at high pressure; (*b*) no xtensive or serious repairs shall be exeuted upon metal which is at high pressre; (*c*) where the alterations or repairs re not of an extensive or serious characer, all metallic parts at high pressure nall be covered by an insulating cap, or rotected by some form of insulating covring, only one part, or several at the ame pressure, to be exposed at any one ime." These regulations are suppleented as follows: A clear, unobstructed pace of not less than four feet behind ach switchboard is required; workmen n cables or mains are compelled to wear ubber gloves; insulation, throughout heir entire length, of all high-pressure onductors in shops or factories is enorced; all examinations of high-pressure mains, wires, machines, or apparatus must be made by skilled electrical engineers, or competent managers or foremen, and, except in case of necessity, no examinations or repairs are allowed while a high-pressure is maintained; use in transformer chambers of "switches that can be conveniently operated from the outside for cutting off both the high- and low-pressure connections of the transformer is compulsory;" and the provisions of means for completely disconnecting arc lamps in series from mains, without interfering with the operation of other lights, is insisted upon.

Water-Tube Boilers in High-Speed Ocean Steamers.

A GREAT deal of wrangling over the merits and demerits of water-tube boilers for marine service has been indulged in, and it can hardly be hoped that the debate is yet ended. There are still many who believe that the older type of marine boiler is the best, all things considered. Nevertheless, water-tube boilers are steadily making their way in marine engineering. We believe it to be the opinion of most close observers that this class of boilers will prevail for steamships. The difficulties to be surmounted in their application to this purpose were great, but modern engineering is not daunted by great difficulties. We have reached the era of high speeds in marine propulsion. It has come in with the era of high steam pressures, and high steam pressures have logically led to the era of marine water-tube boilers. The extent to which this innovation is about to be carried is well indicated in a paper read by M. Sigaudy (July 6) before the International Congress of Naval Architects and Marine Engineers, and printed in *The Steamship* for August. In this paper an example of a marine water-tube boiler carrying three hundred pounds steam pressure per square inch is cited, and the author presents the details of a boiler designed for a large steamship, in which a similar pressure may be maintained. Comparing the water-tube boilers already used in large steamers with those used in Thornycroft's torpedo boats, the author says: "Certainly a great step has been made with water-tube boilers having large-size tubes, and remarkable results have been attained already; but these boilers would never bear the tests which torpedo boats undergo. The tubulous boilers of the latter have supported a combustion of eighty pounds per square foot of fire-grate. Of course, the idea" (in the scheme presented by the author to the International Congress) "is not to put on board of a large steamer a great number of torpedo boilers . . . but rather to adopt boilers constructed on the same principle as these, and adapted to the wants of a long service and great endurance at sea on board of a large vessel. Thus the diameters of the boiler chests must be larger; the tubes that now have about one inch internal diameter will be increased to one and one-half inches, and perhaps a little more. The thickness may also be much greater. Finally, the whole must be combined to make the most of the available space of a large vessel." Without going into the argument made by the author in favor of such boilers as compared with cylindrical boilers, we pass to his conclusion that the reduction in displacement in a large modern steamer directly and indirectly due to the substitution of water-tube boilers for cylindrical boilers may, with the same weight of paying cargo, be three thousand tons; and that, since the dimensions of ocean steamers are limited by the depth of water in harbors, a great increase of speed can be secured only by reduction of total weight. In conclusion, the prediction is hazarded that the introduction of the water-tube boiler into marine service will prove a greater advance than the substitution of the screw for paddle-wheels, the adoption of compound engines, or triple and quadruple compounding.

Portable Recorder for Tests of Metals.

An attempt to supply a long-felt want in engineering appliances is illustrated and described in *Industries and Iron* (August 6). It is the invention of Gustavus Charles Henning, and the description referred to was first presented before the Iron and Steel Institute at Cardiff. The following abstract will show the purpose of the instrument, and the inventor's idea of what such an appliance should be capable of indicating. It may first be premised, however, that many inventors of eminence in the profession of engineering have essayed to solve this problem. Among these may be named Wicksteed, Unwin, Kennedy, Barr, Gray, Olsen, Mohr, Federhaff, and Grafenstaden. It appears, therefore, that Mr. Henning has undertaken a severe task. He speaks of all the inventions hitherto devised as wanting in some particular or particulars, and it is not unlikely that his own invention may be found wanting in some respect, after its efficiency has been put to the test of actual service under all conditions that may arise. Whatever deficiencies it may develop, it has the immense advantage of being portable; it may be carried to and from the works where tests are to be made in the same way that a steam-engine indicator is carried, and used without the costly preparation required with some of the devices above named. It is in itself aiso much cheaper than apparatus heretofore used. We shall not attempt a detailed description of it, but will content ourselves with a summary of the essentials which, the inventor claims, should be embodied in such an instrument, and which, presumably, he thinks he has attained. "Such an instrument must be portable and compact, requiring no extra precautions in adjustment or regulation, and, without having the accuracy of an instrument of precision, must be perfectly trustworthy, and as correct as the other apparatus with which it is used. It must cover a wide range of work of short and long, large and small test-pieces, such as are found in general use, and must be applicable to hard and soft materials as well. The apparatus should be applicable in a horizontal as well as in a vertical position. Moreover, it should give a complete record from beginning to end of the test, showing the more important elements on an enlarged, and the lesser on a natural, scale. Thus while elongations within the elastic limit (yield-point) are very minute and must be recorded on a magnified scale which is trustworthy, changes of length beyond this critical point are very large, rapid, and variable; hence measurement with a steel scale suffices, and the record on a diagram may be on actual scale. This change of scale must, however, be positive, controllable, and at a fixed instant or point, and must not introduce errors in the record. In cases of materials of slight extensibility, however, the entire record should be on one scale from beginning to end, and the instrument should be so attached that it does not nick or injure the material so as to affect its point of rupture or strength." The design of the instrument must also prevent the introduction of errors by slipping or tilting consequent upon changes in shape of the material under test, and must also admit the application of checks upon the accuracy of the instrument at all times. It must also provide for an autographic record of properties of the material by which the effects of hardening, cold rolling, tempering, etc., can be permanently indicated. "With the use of such a recorder, it would become instantly apparent whether the material had been previously strained to raise the elastic limit, as is well known to have been done. Overheating of material would be clearly indicated by the change in curve, and the general uniformity of any lot of material could be determined." The instrument ought also to be applicable to compression tests. The instrument to which, on account of its small size and portability, the name of "Henning pocket recorder" has been given is an ingenious piece of mechanism; it draws diagrams upon paper fixed upon a rotating drum in a manner analogous to the action of a steam-engine indicator. We regret that it is not practicable here to describe its parts and operation in detail, as it is in our opinion, destined to become a useful addition to existing means of studying and ascertaining properties of constructive materials.

Submarine Coal Mining in Spain.

THE *Colliery Guardian* (July 30) says that "the Real Asturiano Zinc Mining Company has for several years worked a colliery at Arnao, in the Asturias, upon a seam varying in thickness up to a maximum of 39 feet, which comes to the surface at about 100 feet to 130 feet above the sea-level, and about 200 yards from the shore. The dip is northerly, or seawards, but, the inclination—23½ degrees—being greater than that of the sea-bottom, the cover increases rapidly in depth; the thickness of the overlying measures of shale and sandstone, which is only 40 meters at the shore line, having increased to 180 meters at the bottom of the mine, now 200 meters below the sea level and 500 meters distant, on the slope from the outcrop." Two different systems are followed, one when the ground worked is above the sea-level and the other when it is below it. The latter, or submarine, has a vertical shaft 76 meters deep, sunk from a point about 20 meters above the sea, the bottom, 56 meters below the sea, being in the seam, which is followed downward by a slope on the dip of 23½ degrees. Working levels in the seam are turned off from either side of the main incline at vertical intervals of about 10 meters, but only the alternate ones are driven through and used as main drawing roads, the intermediate one being cut out, as required by the working.

Removal of Internal Corrosion from the Mains of Waterworks.

THE obstruction of flow and consequent reduction of pressure due to internal corrosion of the mains of waterworks have often caused serious trouble to the engineers in charge. Much study has been given to means for removing the accumulated obstructions arising from this source, which retard the flow, not only by reduction of the interior diameter of the mains, but also by their great increase of friction as compared with the friction of the smoother interior of the pipes when first put down. Any experiences in the successful removal of obstructions thus formed must be of value to engineers who find themselves in the presence of a similar difficulty. Such an experience with the water mains at Kendal, England, is recounted in an interesting paper by Mr. T. H. Ritson in *Journal of Gas Lighting* (Aug. 3). It appears that there are two distinct districts of water-supply in Kendal, a low service and a high service, in the latter the water being taken from a reservoir 464 feet above ordnance datum. The obstruction arising from corrosion was met with in both these services. When Mr. Ritson took charge of these works, they had previously been in the hands of a private company. He found the state of the mains very bad; through abnormal leakage, waste, and obstruction, the supply was exceedingly unsatisfactory. This unsatisfactory condition of the supply had led to the purchase of the waterworks by the local authorities, and the employment as manager of Mr. Ritson. Increase of the capacity of the works was at once proposed, and this is now in progress, a new reservoir being now partly constructed. Before going to any considerable outlay or extensions, the author recommended the scraping of the six-inch trunk main and a four-inch leading main, with a scraper of the Appold type as modified and improved by Mr. T. Kennedy. As so modified, "the scraper consists of two distinct parts connected by a swivel joint, the front carrying eight steel scrapers, and the rear portion propelling pistons. Leather disks, intersected by radial cuts, and stiffened at the back by lead plates, are placed behind each piston. The springs, with steel scraping edges are arranged in sets of four each,—the set behind breaking joint with the set in front. The cutting edges are set in such a way that, should the scraper encounter anything in the shape of a projection, such as ferule screwed into the pipe, the whole machine will slew, or turn round, and thus pass the obstruction without getting blocked; while the leather packings will fold back, and pass any obstructions that can be passed by the pistons themselves." It is thought advisable to have two sets of pistons, one of smaller size than the other, and to use the smaller size first, following with the larger. The description of the actual work of scraping the mains follows: "Men were posted along the six-inch main running from the reservoir, at intervals of twenty-five yards, with instructions that, directly the scraper passed underneath (which can be easily distinguished by a rumbling noise), each man should shout 'passed' to the one in advance. There were several stoppages of the scraper; but its position was easily detected by the stethoscope, from the sound of the water rushing past. One cause of the stoppage was found to be due to about twelve pounds of lead—the result of a badly-run joint. The scraper was inserted a second time in the hatch-box of the reservoir, and, on the water being turned on, an exciting chase took place, for a distance of 2,523 yards was reached in seventeen minutes. A good deal of filth and corrosion was removed on each occasion, the main being afterward well flushed. One length of main was found to be so badly corroded that, in some places, there was barely a 2½-in. waterway through it; and, as the pipes had not been treated with Dr. Angus Smith's composition, the 'carbuncles' of oxid of iron had coalesced to such an extent, and were, moreover, so firmly fixed to the interior surface of the pipes, that it was regarded as next to impossible to successfully scrape them. In the end, it was deemed advisable to replace the main with a new six-inch one." The experience with the scraping of the 830 yards of four-inch main is not less interesting and instructive. Both give unmistakable positive evidence of the value of the Appold scraper as a means of exploring and cleansing water mains, and negative evidence of the usefulness of Dr. Angus Smith's composition as a preventive of corrosion. The supply was so much increased by this scraping that, even without the extensions in progress, it is now almost satisfactory.

Purification of Gas.

A PAPER by Mr. D. M. Nelson, read before the Scottish Gas-Lighting Association and printed in *The Gas World* (August 7), on the best and most economical means of purifying gas, did not appear to be wholly convincing to those who listened to it. In the discussion elicited by the paper, it was handled rather severely. The burden of the paper was an attempt to prove the superior value of lime used in conjunction with oxid of iron to that of lime used exclusively, as a means of purifying illuminating gas. Mr. Nelson maintained that neither of these substances is in itself a complete purifier; but he claims that, taken together, they combine all the elements necessary to complete an economical purification. It was, however, intimated that much care in the selection of the bog ore is required, as well as in its treatment, to secure the most approved results. For example, it had been found that a cargo of uniform quality distributed among half a dozen different gas works in the same district did not, by any means, give like results either in economy, or in quality of gas, although similar mixtures of coal were used. The differences are partly accounted for by differences in local conditions, but long study and experience point to the conclusion that individual skill is a large factor. The difficulty in disposing of the spent lime in gas works has much increased. Owing to improvements in gas manufacture, spent lime no longer has the value as a fertilizer it once had, and is not now in demand for agricultural purposes; it has become substantially a waste product. Farmers will not accept it as a gift. On the other hand, oxid of iron, after its use as a purifier, is, on account of the chemical substances with which it is charged, a valuable article of commerce, in active demand. It is shown that, acting successively, these two materials much more effectively purify the gas than either used by itself, and also that three purifiers may be worked to great advantage where four are not practicable; but five are preferable,—No. 1, a catch purifier containing oxid, receiving the gas first, and passing it on to No. 2, also containing oxid, while the third, fourth, and fifth of the series contain lime. The powerful action of the oxid saves the lime, which, having much less to do in the process, is not so soon spent, and the quantity of spent lime is largely decreased. Revivification of the oxid is effected by simple exposure to the air for a sufficient period. It also takes a considerable time to so load it with impurities that it can be sold as a commercial article. In conclusion, it is said that, by the use of the oxid in the manner indicated, the cost of purification has been lowered from two pence per thousand cubic feet to three-fourths of a farthing. In the discussion which followed, however, it was maintained that two pence per thousand cubic feet was an exorbitant price for purification by the old method, and that the statement of economy based upon such an estimate was entirely unfair. The reduction in cost is also chargeable to a six-per-cent. reduction in the illuminating power of the gas, which, at the same price for gas, comes out of the pockets of consumers. It was also intimated that some managers of gas works who have adopted oxid purification would be glad to go back to lime, if they could. It appeared, also, to be the opinion of the meeting, as well as of the author, that ashes may be used in the catch-purifier as a sufficient substitute for the oxid.

Natural Ventilation.

THE subject of forced draught in buildings has been treated extensively of late in architectural and building publications, and in newspapers exclusively devoted to the interests of the heating and ventilating business. The fact that in very many cases artificial ventilation is, for numerous reasons, impracticable, and that in such cases the natural draft of ventilating flues must be relied upon for the removal of foul and the supply of fresh air, seems almost lost sight of among the flood of current periodical literature devoted to the discussion of ventilation. Perhaps this should be neither wondered at or criticized. The tendency of modern building has been increasingly toward structures of a class which, if systematically ventilated at all, must employ some means of effecting an artificial circulation. The importance of forced ventilation, and its availability as a general method, have been much enhanced during the last twenty years. At the same time, buildings to which this system cannot be applied are, like the poor, "always with us," and they present ever-varying problems to be solved, and difficulties to be overcome. It is, therefore, with pleasure that we perceive the discussion of this subject renewed, so to speak, in an excellent engineering contemporary, *The Canadian Engineer* (August). We observe, however, that the writer of the article, "Natural Ventilation," includes in his discussion wind-driven devices for application to the out-door ends of ventilating flues for creating a draft, which are, strictly speaking, mechanical methods, as much as interior fans, driven by steam, gas-engines, or electric motors. Speaking of the difficulty (impossibility, we should call it) of obtaining anything like uniform natural ventilation for both warm and cold weather, the author, Mr. W. M. Watson, does not seem to emphasize the fact that neither very cold or very warm weather presents the maximum difficulty. The most imperfect natural ventilation is in medium weather,—too cool to permit the free opening of windows and doors, yet too warm for the maintenance of full fires in furnaces. In cold weather, in a house supplied with a warm-air furnace, and with a well-arranged system of ventilating flues, very good ventilation may be secured. In warm weather, when the fires are out, the open windows and doors supply ample admission and outflow of air; but on a chill day the doors and windows may be closed without a rekindling of the fires, and then ventilation is liable to be extremely defective. However, the cases that will not admit of artificial ventilation at small expense have of late been greatly reduced in number by the introduction of small, cheap motors. One of the greatest benefits to mankind resulting from the modern use of electric motors is the possibility of securing by this means good ventilation at times and in situations where effective ventilation would otherwise be impossible. Mr. Watson adopts the view that fresh air, in natural systems of ventilation, should be brought in at the ceiling; he also seems to think that outlets for impure air should be about at the same level, basing his views upon experiments which he does not authoritatively quote, but which he assumes to have settled a much-disputed question.

Theory and Practice in Trade Teaching.

Sir Philip Magnus recently delivered an address before the Society of Arts, section "A" (reported in the *Journal of the Society of Arts*, July 9), in which he states that the institution of trade schools, and the advances which have been made in technical instruction, have supplied material for a new chapter in pedagogy, which is yet to be written, and which may at any time be added to the science of education. The principal way that technical training for any trade is best learned is actual practice in the factory or shop. In the trade schools this method has been adopted and adhered to. Difficulties have arisen in carrying it out. One difficulty pointed out is the exact indication of the kind of theory which ought to be taught in the trade schools in conjunction with practical work. There are those who criticise the courses of instruction in use in the English trade schools, and think them ill-adapted to the purpose in view. The author of the paper says that the fact that thousands of workers, in some of the largest and most important industries, are not reached by instruction in the trade schools was brought prominently to his notice some time since, when he was requested to ascertain what proportion of the candidates at the technological examinations succeeded in qualifying for full certificates by passing in certain allied branches of science in science and art departments. He found that less than seventeen per cent. of the successful candidates were so qualified, and in some of the industries the proportion was much smaller. In a very interesting paper, which all who are interested in trade schools would do well to read, he discusses what he calls the "methodology" of trade teaching, going rapidly over the subject, throwing out suggestions, and indicating some of the difficulties involved.

THE CONTINENTAL PRESS

The New House of the German Engineers.

WE have already noticed the completion of the new building in Paris for the *Société des Ingénieurs Civils de France*, and now comes an account of the handsome new home of the *Verein Deutscher Ingenieure* in Berlin, the dedication ceremonies of which are given in the *Zeitschr. d. Ver. deutscher Ing.* for June 26. The building which is now completed has been under consideration for more than three years, and, as the result of a competition, the plans of Messrs. Reimer and Korte were accepted and the corner stone laid in April of last year. The design, which is the renaissance school, is well adapted for the purposes of the society, and, while the general effect of the structure is simple, the walls are relieved by several sculptured tablets typical of the character of the organization. Upon the upper wall, above the carved name of the society, in high relief, appear two seated figures, representing Theory and Practice, while below, on a bracket backed by a carved medallion, is a fine bronze bust of the late Professor Grashof, a replica of the portrait bust which adorns his monument at Carlsrühe. The two lower floors of the building are arranged to be let as offices, thus constituting a source of income, while above these are the rooms for the work of the society, including handsome editorial quarters for the publication of the journal of the society, together with business- and meeting-rooms and the library. The corridors are handsomely finished with marble and oak, and the building is warmed with hot water and lighted with electricity and gas. The entire cost of the structure was $90,000, of which $50,000 is held by the Deutsche Bank on mortgage at 4½ per cent. Both in the architectural and financial management of the work the society has shown excellent judgment and skill and the result of the efforts of the management is a building which, both as a home for the society and as a commercial investment, represents success of the first order.

Inland Waterways in Germany.

AT the present time there appears to be a general interest in central Europe in the development of inland water communication, especially in connection with the opening of waterways connecting southern Germany and Austro-Hungary with the rivers emptying into the North sea. The convention of the German-Austrian-Hungarian Association for Inland Navigation, recently held at Vienna, was the occasion discussion of the important plans which have been under consideration for several years; and of a report of the proceedings in the July issue of the *Oesterr. Monatschr. für den öffent. Baudienst* we give the following abstract:

The three important projects brought before the convention were the Danube-Oder canal, the Danube-Moldau-Elbe canal, and the Danube-Main canal. The first of these is of importance principally because of the outlet it would give to the Prussian and Saxon coal fields. The difficulties involved in its construction, however, and the expense of operation, rendered the project one of doubtful value in the opinion of the convention, although its favorable consideration was urged from Dresden.

The Danube-Moldau-Elbe canal has already been reviewed in these pages in connection with the competitive plans of the various engineers, and it appears decidedly the best of the three plans for connecting the Danube with the North sea. True, many difficulties lie in the way of its successful completion, and engineers are by no means united as to the best method of overcoming the differences of elevation, opinion being divided as to the relative merits of inclined planes, lock, or hydraulic lifts. The principal points discussed at Vienna for this scheme were of a financial nature, and it is doubtless the question of cost and possible income which will govern the choice of plan and route in any case.

The proposed Danube-Main canal is more especially a Bavarian idea, as the canal itself would be in that kingdom, although its construction would also involve the canalization of the upper Main to Aschaffenburg. A decided opposition to the canal is manifested by the agricultural portion of the population, based on the feeling that communication with the eastern grain fields will injure the market for home products. It is by no means certain that this will influence the actual decision, although it is not without political importance.

In spite of the success of those hydraulic canal lifts thus far constructed, there seemed to be a decided preference at the convention for the old-fashioned lock system for overcoming differences of elevation. The more recent idea of inclined planes with ship railways is regarded somewhat doubtfully, and the plans of Lanna & Vering for the Danube-Moldau-Elbe canal are most favorably regarded, because they include only locks, instead of the more mechanical devices.

There is every evidence that both southern and Northern Germany, as well as Austro-Hungary, are all earnestly seeking some satisfactory system of internal waterways which will permit freer and cheaper intercourse for merchandise, especially in connection with the handling of coal and grain ; and in this latter commodity the construction of any one of the proposed canals could not be without effect in increasing the competition between the product of the Hungarian wheat country and the American grain.

Electro-Chemistry in Germany.

In most of the branches of applied electricity progress has been at least as rapid in the United States as in Europe, frequently because there is less opposition on the part of conservative prejudices in the newer country than in the older ones. In the department of electro-chemistry, however, Germany has taken the lead in many ways, and the proceedings of the fourth convention of the German Society of Electro-chemistry, held at Munich in June, and reported in the issues of the *Zeitschrift für Electrochemie* for July 5 and 20, contain much of value and interest not only to professional chemists, but also to those engaged in the commercial and industrial side of the art.

The development of dynamic electricity, so-called, or the production of electricity from power rather than from chemical action, has to a great extent reversed the old idea, and, instead of generating the current from chemical action, the mechanically-produced current is used to effect many chemical reactions in a much simpler and more effective manner than has otherwise been possible.

Leaving out of consideration the revolution which has been wrought in chemistry by the use of the electric furnace, many important simplifications have been effected by the use of the electric current in dialyzing and in capillary reactions.

The action of the current in decomposing compounds and producing new combinations has also been found of great service, while in many departments of both qualitative and quantitative analysis the ever ready electric current has been pressed into most efficient service.

In all these developments the German chemists have been most active, and, among the names of those who have advanced this branch of science, those of Borchers, Nernst, Liebenow, and many others may be mentioned.

At the Munich convention valuable papers were read upon the electric furnace, upon electro-capillary action, upon electro-chemical synthesis, and upon many other problems, including the generation of the current from direct combustion of carbon ; and the number of those who took part in the discussions, and the general interest developed, showed that the questions possessed a technical and commercial interest of immediate importance and value.

The whole subject of electro-chemistry is one which should be given active and energetic study in all industrial establishments, and, until other countries attack the problems with the activity now shown in Germany, they must be content to remain followers in this important department of applied science.

The Diesel Motor.

AMONG the papers presented at the recent convention of the German Society of Mechanical Engineers of Cassel, one of the most interesting was the description, by Herr Rudolf Diesel, of the improved motor which he calls a "rational heat motor."

Herr Diesel has approached the problem of the economical generation of power from combustible material in so intelligent a manner, and his efforts have resulted in the production of a machine so extraordinary in efficiency, that we are certain that the Diesel motor will attract much attention from all who are interested in the economical production of power.

From an account in the *Zeitschr. des Ver. deutscher Ingenieure* for July 10 and 17, we abstract the following description, strongly recommending those interested in the subject to examine the matter fully.

Herr Diesel began by examining the question theoretically, and practically formulated his plans before the motor was designed at all; and his account of his work forms an admirable example of the modern methods of scientific investigation as compared with the old "cut and try" schemes of earlier inventors.

The motor is constructed along the lines of existing gas and petroleum engines, but differs from them radically. There is no explosion, but instead a definite combustion, and the fuel may be gas, oil, or powdered coal. The fuel charge is not drawn into the cylinder with the air and there compressed with it; the air is given a preliminary compression, in two stages, to a much higher degree than is customary, reaching five hundred pounds to the square inch. The final stage of this compression is attained in the first working cylinder, when the fuel is admitted, and is at once ignited by the heat of compression, no special igniting device being necessary. The combustion produces an increase of pressure which impels the piston, and at the end of the stroke the gases expand still further in a second cylinder, after which they are discharged into the air.

The general arrangement of the machine is as follows: Two vertical cylinders have between them a third larger cylinder. All three pistons are connected to one crank shaft, the smaller ones having coincident cranks and the larger one being at 180° from the other two. The large cylinder is double-acting, with stuffing box; the smaller ones have plungers. The lower end of the large cylinder acts as a preliminary air-compressor, feeding into a reservoir from which the smaller cylinders draw. The first small cylinder draws air from the reservoir, and compresses it to a point where it is hot enough to ignite the incoming petroleum, or gas. The fuel is forced into the cylinder, combustion takes place, and a power stroke is made. The exhaust is then made into the upper end of the larger middle cylinder, which acts as a low-pressure cylinder of a compound system, after which exhaust into the air is made. The second small cylinder acts precisely as the first, except that it is compressing when the first is making a power stroke, and *vice versa.* The small cylinders make power strokes every other revolution, while the low-pressure cylinder makes a power stroke every revolution.

The main points of difference between this motor and existing petroleum or gas engines are the following: The very high degree of compression insures a rapid and thorough combustion and a higher upper limit of temperature than is otherwise attainable. Also, the fuel is burned gradually and not explosively, as the indicator cards show, and the combustion can be cut off almost as sharply and definitely as the pressure in a steam engine. The high-pressure gases are fully expanded in two cylinders to such an extent as to abstract nearly all the effective energy, so that the exhaust is quiet in operation, without that barking puff which makes the whereabouts of a gas engine in operation usually so easily recognizable.

The use of the high temperature of compression to insure the ignition results in few failures of ignition, and the gradual combustion maintains the high temperature in the cylinders during the continuous operation of the motor.

The Diesel motor has been very thoroughly tested by a number of able and disinterested experts. During the present year tests have been made at the Otto Gas Engine works at Deutz, at the Sulzer Engine Works at Winterthur, by Prof. Sauvage at Paris, and by Prof. Schröter at the Technical High School at Munich.

Prof. Schröter gives a very full report of his test in the *Zeitschr. des Ver. deutscher Ingenieure* for July 24, and shows that with a Diesel motor built by the Augsburg Machine Works, operated with ordinary American petroleum, an efficiency of 34.2 per cent. indicated power was obtained when working at full load of about 20 h. p., and that an efficiency of 38.5 per cent was obtained when operating under a load of about 10 h. p.

When it is remembered that 12 to 13 per cent. is the highest that can be obtained from triple-expansion steam engines in units of about 1,000 h. p., and that 20 to 23 per cent. is excellent for existing gas engines, the step in advance which Herr Diesel has made with this little 20-h. p. motor must be regarded as noteworthy indeed.

Air-Compressor Explosions.

EXPLOSIONS of receivers containing compressed air are by no means common; indeed, it is generally supposed that air under the moderate pressures used in mining and other operations is practically free from danger of explosion. Several cases, however, have been noted in which dangerous, and even fatal, explosions have occurred. In the issue of *Glückauf* for June 26 is given a very full account of a fatal explosion which occurred some months ago at Dortmund. The violence of the explosion was remarkable, the building being destroyed and the engineer killed, while a fragment of the receiver weighing nearly four tons was thrown over a building nearly 100 feet high, much other damage being done.

The result of the investigation showed that the explosion could not have been due merely to the expansive force of the air in the receiver, since at no time did the pressure exceed 80 pounds to the square inch, there being two safety valves weighted to about 75 pounds on the receiver. The compressor itself was of the well-known Burckhardt type, built by the Duisburg works, and all parts appear to have been of ample strength. The cylinder walls and heads were water-cooled, but the valve chests, containing the slide air valves, were not jacketed. Lubrication was effected automatically, a high-grade cylinder oil, known as valvoline, being used.

At the time of the explosion a thick cloud of smoke rose from the place, and, as soon as the wreck was examined, the inner walls of the shattered cylinders and valve chests were found to be covered with a thick coating of finely-divided carbon, together with small particles of solid matter resembling coke.

These facts suggested the action of explosive gas mixtures, and the oil was subjected to chemical investigation, with the result of proving the lubricant to be a high-grade cylinder oil, igniting at 291° C. and boiling at 375° C., and free from volatile hydro-carbons. Like all organic substances, it was decomposed at red heat, giving off oil gas and leaving a residue of carbon; and 20 grams of the oil was then found sufficient to render one cubic meter of air violently explosive.

Under these conditions it appeared that the absence of water-jacketing on the slide valve chests might permit enough heat to be generated to convert a portion of the lubricant into gas, thus practically charging the entire apparatus with an explosive mixture, the explosive force of which would be greatly increased by the existence of the pressure, which equals that attained by compression in gas and petroleum explosion motors.

These deductions are warranted by other observations. At the "Bommerbanker" mine a slight explosion occurred last year, and, on opening the valve chest, a lining of carbon was found, containing particles of glowing coke. Also at the "Borussia" mine an explosion occurred in connection with a Riedler compound compressor, in December last, the ignition being caused by the approach of a lamp to the valve chest, and the flame being drawn in with the air suction. In a compressor of this design, however, it is hardly possible for the vapor to ignite itself, since the compression is effected in two stages, and the air very thoroughly cooled in both cylinders.

It is very evident from these experiences that, even with the best lubricants, it is important that all parts of an air-compressor should be thoroughly cooled, and that the mere cooling of the cylinders is not sufficient to prevent either the formation of explosive mixtures of air and hydrocarbon vapor, or the ignition of such mixtures when formed.

Questionable Economy of Water Power.

In view of the frequent discussion at various assemblages of engineers as to the actual cost of power derived from various sources, the state of affairs in France, as brought out in an article in the *Moniteur Industriel* for July 3, may prove of interest.

It is often assumed that water power is vastly more economical than any artificial source of energy, since it is furnished gratuitously, so to speak, by nature. As a matter of fact, however, the cost of installation, including the acquirement of water rights and the construction of plant, often brings the fixed charges to a point where the economy over artificial power becomes doubtful. This is especially the case when the supply of water is variable and the demand for power constant, as a reserve engine then becomes necessary, and expense is added to inconvenience.

The fact is that water power is not a natural source, any more than coal, for instance, both having their origin in the processes of nature, but both requiring conversion by highly-organized mechanical methods before they can be regarded as power at all in the commercial sense.

In France, as the article referred to shows, the result of expert investigation, in the course of certain law suits about water rights, has demonstrated that, for purposes demanding uniform and constant power, there is little or no economy in the use of water power.

Decisions by the highest courts have apparently been to the effect that the reverse is true, and, as a result, there is now in France a lively discussion as to the relative value of expert and judicial opinions. At the same time, there seems to be little doubt that a high economy is realized with water power only when there is an ample supply under those natural conditions which render the original cost of installation a minimum, and the expenses of maintenance low. Many cases of this sort occur in Switzerland, and there are numerous examples in the United States, but it should always be remembered that "cost" is a very elastic term, and that it should, in honesty, be made to include, for interest, repairs, depreciation, and other fixed charges, an amount properly representing the true cost in comparison with other sources of power.

The high economy now attainable with various forms of internal-combustion motors, and the cheapness with which fuel gas can be produced from low-grade combustibles for use in such motors, should render such sources of power a subject for thoughtful consideration in comparing the so-called "natural" sources of power with artificial methods; local conditions will often decide against the natural, and in favor of the artificial, power.

The Liernur Sewage System at Trouville.

The Liernur pneumatic system for the removal of sewage has been in operation for more than twenty-five years in Amsterdam and Leyden, and its success in those older installations has led to its introduction in other cities, especially where the fall has been found insufficient for effective gravity water drainage.

The latest application of the method is that just completed at the well-known watering-place, Trouville, of which a description is given in *La Revue Technique* for July 25.

The Liernur system differs from all gravity systems in that the sewage is removed entirely by atmospheric pressure. The discharges from each house are delivered into an air-tight metal reservoir, from which they are in turn drawn by suction into larger collecting tanks, these latter delivering the matter to an out-of-town works, where all the refuse is converted into an inoffensive fertilizer. It will thus be seen that the house service is entirely distinct from the storm water drainage. By thus removing all the sewage in air-tight metal pipes, the highest degree of sanitary excellence is obtained.

Since its introduction in the early seventies, the pneumatic method of Captain Liernur was extended in Amsterdam, until at the end of 1895 the area served contained nearly 85,000 inhabitants, while the military quarter of St. Petersburg, the entire city of Riga, and a number of other places, have been provided with the system.

Trouville is especially well adapted for the successful installation of the method, and the location also makes the application of any satisfactory gravity system impracticable. For the Liernur plant there are provided eleven main collecting tanks, each of these being at the lowest point of the district which it drains. With these tanks, which are air tight shells, all the delivery pipes from the houses connect, while one main collecting pipe runs from the tanks to the poudrette factory. A powerful suction air-pump at the factory makes it possible to produce a vacuum in the system, and once a day the entire system is exhausted. The valves on the connecting pipes between the houses and the tanks being closed, a vacuum is produced in the latter, and, connection with the pump then being shut off, the rapid opening of the house connections causes an immediate and entire clearing of all the house tanks into the vacuum tanks. The house connections are again closed, and the vacuum tank exhausted into the main leading to the factory, air being admitted by a special valve to permit the flow to take place. The entire operation is the work of one man, who makes the tour of the town in about four hours, his only labor being the opening and closing of the valves, the pump at the works being kept in constant operation during the time. The manufacture of the poudrette being conducted at a proper distance from the city, there is nothing to give offence; all the tanks are underground, the valves being operated from connections at the surface in the streets.

Owing to the manner in which the material is collected, its conversion into fertilizer is commercially possible so as to yield a considerable revenue, and at Trouville, where the population during the season reaches 20,000, it is estimated that the receipts from the sale of poudrette will furnish a material income over and above all operating expenses.

As the practical value of the Liernur system has been a subject of discussion among sanitary engineers for a number of years, this new installation will be watched with interest, especially in view of the importance of the place where it has been introduced.

Explosions in Mines.

THE fact that the production of firedamp in coal mines bears a relation to atmospheric conditions is well known, and it has been the practice in Germany for several years to keep a record of the variations in barometric pressure in connection with the explosions in coal mines, in order to investigate the subject.

The issue of *Glückauf* for August 7 contains the report for 1896 for the Dortmund mining district, with a very instructive diagram of the variations in atmospheric pressure for each month, as observed at Dortmund and at Essen, with the explosions of the year indicated at the day and hour of occurrence.

From a number of investigations the following laws have been deduced for the relation of gas production and atmospheric pressure.

As a rule, the proportion of gas in the air of mines diminishes with increasing atmospheric pressure, and increases with diminishing pressure.

The volume of gas increases the more rapidly the quicker the barometric curve falls, and *vice versa*.

If, after a rapid rise in the barometric curve, the pressure increases much less rapidly, or comes to a standstill after a maximum has been attained, a slow increase in the volume of gas appears; while, if, after a rapid fall in the barometer, the pressure becomes stationary, there follows a slow diminution in the volume of gas present. It therefore appears that the maximum and minimum points of barometric pressure do not always correspond to the minimum and maximum points of the gas curve.

The report for the last year contributes some interesting data upon the subject, and confirms in many points the above laws. In a total of 42 explosions, 27 or 64 per cent., occurred during low atmospheric pressures or periods of rapidly-falling barometer, while 15 explosions, or 36 per cent., took place at other times. During the six years that these records have been kept in the Dortmund district the proportion of explosions occurring at periods of low barometric pressure has been about 60 per cent., and, while this is hardly enough to permit predictions or warnings to be made with much confidence, it is believed that the connection is sufficiently important to warrant further investigation.

An examination of the chart is more convincing. Thus, in January, 1896, a period of low pressure occurred between the 13th and 16th of the month, during which time four disastrous explosions took place in as many different mines. Again, in the middle of November, during a fall of nearly 20 mm. in pressure, six explosions occurred, and, in general, the grouping of the disasters upon the plotted barometer-curves shows a relation much more definite than is deduced from the tabular averages. Similar charts might readily be produced in the United States from the barograph records of the weather bureau, without requiring any additional observations, and it is possible that, by extending the investigations over a wider area, more definite conclusions might be reached.

The Electric Traction of Boats.

THE application of mechanical traction to the haulage of boats on canals and rivers has been made as yet only in a few instances, the use of animals being in many cases found to be more economical under the peculiar conditions of the service. Attempts are now being made in France to introduce electric traction, and in *La Revue Technique* for July 25 an account is given of the systems of MM. Denèfle & Co., which seem thus far to have given encouraging results.

Two methods have been applied, of which only the first can properly be called a traction system. In this method a so-called "electric horse" is employed, the novel animal being a sort of electrically-propelled tricycle, constructed somewhat like a traction engine, but propelled by electric motors, and taking its current from an overhead trolley wire. No track is required, the machine travelling along the tow path, and hauling the boats by means of a tow rope. The motorman rides in a sort of cab, and not only directs the propelling apparatus, but also steers the machine.

The overhead wire is carried over the middle of the tow path upon supports much like those used for tramway purposes, the poles being upon but one side of the path and the wire being carried on overhanging brackets. The trolley pole is free to follow the line of the wire to a sufficient extent to maintain its contact even should the machine not keep exactly in the middle of the road, and, so far as mechanical performance is concerned, the whole apparatus seems to work very well.

The second method described is rather a propelling device, and consists of an electrically-operated screw propeller, which may be attached to any existing canal boat. This device is ingenious, as it is entirely contained in the rudder, which is formed of a sheet-iron box, in which is placed an electric motor operating a screw propeller projecting from the end of the rudder.

The current is conveyed to the motor by means of wires, as usual, the entire working machinery, with the exception of the propeller itself, being enclosed water-tight, in the rudder. The connections are carried down through the rudder post, and it is a matter of only a few minutes to unship the common rudder and substitute one of the propelling ones upon any canal boat.

As in the previous case, the current is taken from a trolley wire carried along the tow path, the boat being provided with a trolley pole for the purpose.

The greatest element of merit in these devices lies in the fact that absolutely no change is required in the construction of existing boats; nor are any new motor boats required. At the same time the systems involve the construction of power houses and the erection and maintenance of trolley wires.

A thorough test of electric traction is to be made on the canals of the Aire and the Deule, between Marles and Pont-à-Vendin, under exceptionally favorable conditions, and, should the economy of this form of power traction compare favorably with animal power, in point of economy, the system doubtless will be extended throughout France and elsewhere.

Electric Plows.

ELECTRIC traction has been applied to the operation of plows, both in France and Germany, for the past two years, and the results of the apparatus, as improved by experience, are sufficiently satisfactory to warrant the introduction of electrically-propelled plows as a commercial product.

The latest form of apparatus is described in *Die Elektrizität* for July 17 and 31, from which some interesting details may be abstracted. The general principle is practically the same as that of other power-propelled plows, a gang plow being hauled back and forth across the field. The electric motor is carried on the plow itself, and drives a pocketed chain sheave, which engages with a chain stretched across the field and anchored at each end. The current is conveyed to the motor through a pair of trolley wires supported on carriers, which may be moved laterally across the field as the work progresses. Where no other source of current is available, a portable dynamo is provided, driven by an ordinary agricultural portable engine, and, since the current may be transmitted any reasonable distance without difficulty, the engine may be placed near a convenient water-supply, thus avoiding the necessity of carrying feed-water. When electric current from a general station is to be had, the use of electric plows offers numerous advantages. Current which is used for lighting by night can be fully utilized in the motors by day, and the introduction of a number of electric plows might make the installation of an electric plant profitable in sections where otherwise the demand for current might scarcely warrant the outlay.

The general advantages of power-plowing, and the localities in which the use of power is commercially profitable, have been well investigated already, in connection with the use of steam plows. Electricity adds principally the general advantage of power transmission from any convenient point, and does away with the necessity of having the entire power plant in the field where the work is to be done, and, in time, its wider introduction may lead to the establishment of agricultural power stations furnishing current not only for plowing, but for all the manifold purposes required in farming. Installations which at present are too expensive for any but the great landed proprietors may thus, by combination, be brought within the reach of many smaller farmers.

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Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila., Pa.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
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Australian Mining Standard. *w.* Sydney.
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
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Builder. *w.* London.
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Bulletin of the Univ. of Wisconsin, Madison, Wis.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont
Century Magazine. *m.* New York.
Chautauquan. *m.* Meadville, Pa.
Colliery Engineer. *m.* Scranton, Pa.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
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Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
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Domestic Engineering. *m.* Chicago, Ill
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Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* New York.
Electricity. *w.* London.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Elektrotechniker. *b-m.* Vienna.
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Forum. *m.* New York.
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Garden and Forest. *w.* New York.
Gas Engineers' Mag. *m.* Birmingham, Eng.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glasers Ann. für Gewerbe & Bauwesen. *s-m.* Berlin.
Gunton's Magazine. *m.* New York.
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Industries and Iron. *w.* London.
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Iron Age. *w.* New York.
Iron and Coal Trade Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
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Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
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Journal Political Economy. *q.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Journal of the Society of Arts. *w.* London.
Journal of the Western Soc. of Eng. *b-m.* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kan.
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Marine Engineering. *m.* New York.
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McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
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Nature. *w.* Paris.
Nature. *w.* London.
New Science Review. *qr.* New York.
Nineteenth Century. *m.* London.
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Oesterr. Monatsschr. für den Oeff. Baudienst. *m.* Vienna.
Oesterr. Zeitschrift für Berg- & Hüttenwesen. *w.* Vienna.
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Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Révue Technique. *b-m.* Paris.
Safety Valve. *m.* New York.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweitzerisches Bauwesen. *w.* Zurich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Scientific Machinist. *s-m.* Cleveland, O.
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis, Mo.
Stationary Engineer. *m.* Chicago, Ill.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J
Stone. *m.* Chicago, Ill.
Street Railway Journal. *m.* New York
Street Railway Review. *m.* Chicago, Ill
Technic. *yr.* Univ. of Mich.
Technology Quarterly. Boston, Mass.
Tradesman. *s-m.* Chattanooga, Tenn
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill
Western Railway Club, Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Zeitschrift für Lokomotivführer. *m.* Hannover.
Zeitschrift für Maschinenbau & Schlosserei, Berlin.
Zeitschrift des Oesterr. Ing. und Arch. Ver. *w.* Vienna.
Zeitschrift des Ver. Deutscher Ingenieure. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle, a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.
Zeitschrift für Instrumentenkunde. *m.* Berlin.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Barracks.

The Archduke Frederick Barracks and Mili- ary Hospital at Teschen. (Die Erzherzog Friedrich Kaserne und das Truppen Spital in Teschen.) With photographic views and plates of details of these important buildings. 2500 w. 3 plates. Oesterr Monatschr f d Oeffent Baudienst—August, 1897. No. 14731 D.

Century Building.

The Century Building, St. Louis. An illus- rated detailed description of a marble palace for business and amusement. Contains stores, offices and a theatre. 8000 w. In Arch, Aug., 1897. No. 14926 G.

Dock Warehouses.

See same title under Marine Engineering.

Fire-proofing.

Details of Fire-proof Construction with Burned Clay. Peter B. Wight. A study of column protection. Ill. 2500 w. Br Build—Aug., 1897. No. 14944 C.

Foundations.

Foundation for the Canal & Claiborne Elec- ric Railway Power House, New Orleans, La. Illustrated description of a building foundation on soft ground presenting features of interest. 500 w. Eng News—Aug. 19, 1897. No. 16800.

Hospitals.

Cottage Hospitals. Thomas W. Aldwinckle. History of this movement as given in a book by Henry C. Burdette, dealing also with the architecture. 4700 w. Jour Roy Inst of Brit Arch—July 29, 1897. No. 14652 A.

Library Building.

The New Massachusetts State Library Build- ng, at Boston, Mass. Brief illustrated descrip- ion of the new extension to the Massachusetts State Capitol. 1500 w. Sci Am Sup—Aug. 28, 1897. No. 14864.

HEATING AND VENTILATION.

Churches.

Heating and Ventilating Churches. An in-structive chapter, reprinted from book by George W. Kramer, touching on the essential eatures. 6000 w. Met Work—Aug. 21, 1897. No. 14812.

Court House.

Heating and Ventilation of the Jefferson County Court House, Louisville, Ky. Illus- rated description of building heated by the fan system. 800 w. Heat & Ven—Aug. 15, 1897. No. 14661.

Exhaust Steam.

Utilization of Exhaust Steam. George L. Thayer. Read before the Northwestern Elec- rical Assn. Describes the earliest attempts at central station heating, the difficulties met, and mprovements made, the different systems, condensation, and related matters. 2000 w. W Elec—July 31, 1897. No. 14429.

See same title under Electrical Engineering, Power.

Hot Water.

A Hot Water Heating System for Single Floors. (Beschreibungeiner Etagen-Warm Wasser Heizung.) Describing a system for warming apartments by water heated from the kitchen range; as applied in Italy. 2500 w. Gesundheits Ingenieur—July 31, 1897. No. 14782 B.

Normal School.

Warming and Ventilation of the State Normal School Building, Salem, Mass. Illustrated description. The specially interesting features are in the compactness of the systems of air ways, and in the resulting economy of floor and room space; in the reduced cost and methods for the economizing of heat. 2300 w. Eng Rec—Aug. 21, 1897. No. 14831.

Residence.

Combination Heating System in a Philadelphia Residence. Illustrated description of successful installation at the residence of T. Henry Asbury, Oak Lane. 500 w. Heat & Ven—Aug. 15, 1897. No. 14662.

Steam Fitting.

Steam Fitting. James F. Hobart. Part first discusses the handling of pipe, straightening of bent pipe, cutting-off, &c. Ill. 1500 w. Dom Engng—Aug., 1897. Serial. 1st part. No. 14854 C.

Ventilation.

Natural Ventilation. W. M. Watson. Suggests systems of ventilating not covered by patents, and discusses methods that have been found satisfactory. Ill. 2400 w. Can Eng—Aug., 1897. No. 14551.

The Mortier Ventilator. (Der Mortier Ventilator Anlager der Zeche Alma.) A powerful fan ventilator and steam plant recently erected at the Alma mine at Gelsenkirchen. With plate showing general arrangement. 1000 w. Gluckauf—July 24, 1897. No. 14741 B.

The Purification of Basements and Arrangement of Ground Ventilation. (Die Reinigung des Untergrundes und Einrichtung einer Boden ventilations-anlage.) Discussing the importance of proper ventilation of basements as well as the surrounding soil, both from considerations of health and safety. 2500 w. Gesundheits Ingenieur—July 31, 1897. No. 14783 B.

LANDSCAPE GARDENING.

Difficulties.

Planting for the Future. H. A. Caparn. The lack of appreciation of the landscape gardener's work, due to defective imagination in the clients. 900 w. Gar & For—Aug. 11, 1897. No. 14575.

Private Grounds.

The Planting of Private Grounds. Editorial calling attention to sins of omission and commission, such as the utilizing of natural formations in grounds, the grouping of stones and foliage, cutting out of trees and shrubs, the planting too much, &c. 1600 w. Gar & For—Aug. 25, 1897. No. 14867.

The Dalles.

The Dalles of the St. Croix, Wisconsin and Minnesota. Mary C. Robbins. A description of this region, 150 acres of which have been reserved as an interstate park, and the movement on foot to secure 1550 acres. 1800 w. Gar & For—Aug. 25, 1897. No. 14868.

Trees.

The Rejuvenescence of Old Trees. Editorial account of an attempt to save a white oak growing in the Arnold arboretum. The result was successful. Also general discussion of the subject. Ill. 1300 w. Gar & For—Aug. 11, 1897. No. 14574.

The Use of Trees and Shrubs with Leaves of Abnormal Colors. Editorial comment on the art of garden design so far as it relates to the selection of trees and shrubs for some peculiarity of form or color. 900 w. Gar & For—Aug 4, 1897. No. 14467.

PLUMBING AND GAS-FITTING.

Back Vent Connections.

How Back Vent Connections Must Be Made in New York City. James J. Lawler. Calls attention to a few special requirements not usually understood by plumbers. Ill. 1000 w. Dom Engng—Aug., 1897. No. 14852 C.

Baths.

Public Baths in Europe. Edward Mussey Hartwell. An account of the origin and history of the public bath-house movement in certain of the leading industrial countries of Europe, showing what the experiences of the cities teaches as to the best methods of locating, planning and maintaining baths for the people. Ill. 22500 w. Bul Dept of Labor—July, 1897. No. 14480 D.

Details.

The Great Importance of Perfection in Details in Sanitary Work. J. Kemsley. Read at the monthly meeting of the Institute of Sanitary Engineers. Gives examples of serious troubles caused by trifling matters, or what a little attention would remedy. 3000 w. Dom Engng—Aug., 1897. No. 14855 C.

Drains.

Examining and Testing Old Drains and Sanitary Appliances. T. E. Coleman. Reprint from a book received from Messrs. Spon & Chamberlain. Urges the periodical examination and testing as a matter of health and expense. Directions for testing are given. 2500 w. Dom Engng—Aug., 1897. No. 14853 C.

Police Station.

Plumbing in a Police Station. Illustrated description of the work in the Ninth Precinct Police Station-house, in Charles Street, New York City. 900 w. Eng Rec—Aug. 14, 1897. No. 14648.

Waste Closets.

Slop-Water Closets in England, Their Manufacture and Use. J. A. Turner. Describes what is meant by a slop-water closet and the advantages in its use over the ordinary fresh-water closet. Types illustrated. 1700 w. Brick—Aug., 1897. No. 14434.

Waste Water for Flushing Purposes. A. Edward Allen. Recommends the use of appliances for storing the slop and rain water for flushing. 1200 w. Ill Car & Build—Aug. 6, 1897. No. 14618 A.

MISCELLANY.

American Architecture.

A Hopeful View of American Architecture. Allen B. Pond. Calls attention to the awakened interest in architecture, and to the indications of improvement. The restrictions and difficulties are also discussed. 1600 w. In Arch—Aug., 1897. No. 14924 G.

Brownstones.

Brownstones. T. C. Hopkins. From Appendix to the Annual Report of Pennsylvania State College. Part first treats of their texture and microscopic features, and the causes of decay in the cities. Ill. 4500 w. Stone—Aug., 1897. Serial. 1st part. No. 14675 C.

Ceilings.

Decorated Ceilings. Walter J. Pearce. Considers the painted decoration. Ill. 1800 w. Plumb & Dec—Aug. 2, 1897. No. 14563 A.

Centennial Buildings.

Some Notes on Tennessee's Centennial. F. Hopkinson Smith Contains an account of the fine buildings, with illustrations by the author, and criticisms. 5000 w. Scribner's Mag—Sept., 1897. No. 14856 C.

Chimneys.

The Statical Computations for Tall Chimneys. (Die Statische Berechnung Grosser Schornsteine.) Discussing the conditions of stability of tall masonry chimneys under wind pressures. 1500 w. Oesterr Monatschr f d Oeffent Baudienst—August, 1897. No. 14735 D.

Church.

St. Kavin's Church, Traumburg, Bohemia. Bertram G. Goodhue. Illustrated description. 2000 w. Arch Rev, Vol. IV, No. IV. Serial. 1st part. No. 14963 F.

Clay.

The Drying of Clay in Large Masses. (Ueber das Trocknen von Thon in Grössern Massen.) With a description of Toldt's new drying furnace, illustrated. 4500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—July 10, 1897. No. 14763 B.

Competitions.

The Competition for the Proposed New York Public Library. Jack Shingle. A criticism of the features of the competition for the design of this building, and the conditions governing them. 900 w. Arch & Build—Aug. 7, 1897. No. 14526.

The Mexican Federal Palace Competition. Order for the opening of an international competition for the design of the edifice destined to serve as the palace of the Federal legislative ower of the Mexican Republic. 2500 w. rch, Lond—Aug. 6, 1897. No. 14646 A.

English Architecture.

Some Thoughts on Old English Architecture. . Guy Dawber. Read before the Bristol and loucestershire Archaeological Society. Traces me of the methods and traditions of building England, noting their bearing on its archi- ecture particularly in the Cotswold country. 00 w. Builder—Aug. 21, 1897. No. 14- 45 A.

Flooring.

Papyrolith and Other Artificial Flooring. In- rmation of papyrolith, cork-stone, and noch's elastic flooring. 1200 w. Cons Repts -Aug., 1897. No. 14442 D.

The Schürmann Solid Floor Construction ith Sheet Iron Keys. (Schürmann's Massiv- ecken auf Wellblechsienen.) The use of stamped eet metal keys enables a practical arch con- ruction to be built between beams without ecial arch bricks or tiles. 2000 w. Schweizer- che Bauzeiting—Aug. 7, 1897. No. 14767 B.

The Wehler Floor Brick. (Der Wellenfalg- egel Patent Wehler.) An improved hollow le for floor and ceiling filling in connection ith iron girders. A peculiar lock joint is used. 00 w. Zeitscher d Oesterr Ing und Arch Ver -Aug. 6, 1897. No. 14730 B.

Greek Architecture.

Grecian Orders of Architecture. Cyrus K. orter. On the development of the architecture f the Dorians and Ionians. Ill. 6500 w. Stone ug., 1897. No. 14674 C.

Heater.

The Junker Water Heater. (Junker's Schnell- üssigkeitserhitzer.) A modification of the unker gas calorimeter for the heating of water r household purposes. 2500 w. Zeitschr d er deutschr Ing—Aug. 7, 1897. No. 14722 B.

Monument.

The Imperial Monument at the Schlossfreiheit at Berlin. (Das Kaiserdenkmal auf der Schlossfreiheit zu Berlin.) An illustrated description with views of details of the fine monument to the memory of the late Emperor William I, recently completed at Berlin. 3000 w. 1 plate. Oesterr Monaschr f d oeffent Baudienst—August, 1897. No. 14733 D.

Pantheon.

The Pantheon, Paris. Historical account of the building of this beautiful edifice, with some reference to its defects. 3000 w. Arch, Lond —Aug. 6, 1897. No. 14647 A.

Pine.

Investigations on the Influence of Wind Cracks upon the Strength of Pine Timber. (Untersuchung über den Einfluss des Blaudwerdens auf die Festigkeit von Kiefernholz.) A very thorough series of tests upon the strength of wind shaken timber, with numerous illustrations, made by the Royal testing laboratory at Berlin. 25000 w. Mitt aus d Konig tech Versuchsaustalten—Part I, 1897. No. 14757 F.

Stone.

Tests of Natural Stone. (Prüfung Natürlicher Gesteine.) A very full series of tables and data of the compressive strength of various kinds of stone, as well as resistance to wear; includes a variety of granites, sandstones and limestones. 18000 w. Mitt aus d Konig tech Versuchsaustalten—Part I, 1897. No. 14758 F.

Tarsney Act.

The Supervising Architect's Office Reorganized. The placing in force of the Tarsney Act by Secretary of the Treasury, with details for its enforcement. 4000 w. In Arch—Aug., 1897. No. 14925 G.

Tenements.

The Tenement House Reform in New York City. S. Parkes Cadman. Treats of recent legislation resulting in the improvement of the tenement districts of the city. 3600 w. Chau —Sept., 1897. No. 14960 C.

CIVIL ENGINEERING.

BRIDGES.

Bascule Bridge.

The Michigan Avenue Bascule Bridge, Buffa- . Illustrated description of bascule bridge ith a differential rolling counterpoise, and its peration. 1800 w. Eng Rec—Aug. 21, 1897. o. 14827.

Coffer-Dam.

The Coffer-Dam Process for Piers. Charles van Fowler. Historical account of the devel- pment, with discussion of why the coffer-dam as gotten into disfavor, with directions that uccess instead of failure may result. Ill. 4000 . Stone—Aug., 1897. No. 14673 C.

Drawbridge.

Michigan Street Drawbridge, Buffalo, N. Y. llustrated description of a double hinged lift- ridge presenting novel engineering features. 500 w. Eng News—Aug. 19, 1897. No. 14- 01.

See same title under Railroad Affairs, Maintenance of Way.

The Hase Drawbridge System (Laufbrücke, System Josef Hase). Arranged especially to permit coal barrows to tip into open cars, and draw up to permit the passage of box cars. 3000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—July 24, 1897. No. 14764 B.

Failure.

The Tarbes Bridge Failure. Particulars and illustration, from *Genie Civil*, making it appear that the cause of failure was due to the design. 700 w. Eng Rec—Aug. 21, 1897. No. 14829.

Foundations.

A New Method of Building Submerged Foundations. Describes a method devised by D. Jordan, with a view to expediting the construction and lessening the cost. Ill. 800 w. Sci Am—Aug. 14, 1897. No. 14568.

The Foundations of the East River Bridge, New York. Illustrations and particulars showing the progress thus far made. 2200 w. Sci Am—Aug. 7, 1897. No. 14471.

Niagara Bridge.

Test of the New Niagara Bridge. Brief report of the test and its success. Ill. 400 w. Ry Age—Aug. 20, 1897. No. 14818.

Pin System.

American and English Bridges. Editorial discussion of why the pin system is used in America and the rivet connections in England. 1600 w. Eng, Lond—Aug. 13, 1897. No. 14833 A.

Stresses.

The Actual Stresses in Bridge Members. A brief account of the instruments used and methods of procedure followed by M. Rabut, in his interesting investigations of actual stresses in the various types of bridges in use on the Western Railway of France. 1200 w. Engng—Aug. 13, 1897. No. 14823. A.

Suspension Bridges.

Modern Suspension Bridges. (Hängebrücke der Neuzeit). A paper by Prof. Mehrtens, with numerous illustrations, and a discussion of the possibilities of the method with modern materials and construction. 10000 w. Stahl und Eisen—June 15, 1897. No. 14745 D.

Victoria Bridge.

The Victoria Jubilee Bridge at Montreal; Grand Trunk Railway. Illustrated description of the tubular bridge across the St. Lawrence at Montreal, and also of the truss span bridge that is to replace it. 3000 w. Eng News—Aug. 26, 1897. No. 14891.

CANALS, RIVERS AND HARBORS.

Bulkhead.

Delaware Avenue Bulkhead, Philadelphia. Description, with illustrations of the general features of the standard sections of timber and concrete work. 1600 w. Eng Rec—Aug. 21, 1897. No. 14828.

Canals.

New York's Canals and Commerce. Alex. R. Smith. The conception, construction, cost, purpose, traffic, improvement and management of the canals, and their effect upon New York's commerce. 4500 w. Sea—Aug. 26, 1897. No. 14882.

The Rebuilding of the Rhine-Marne, and Saar-Kohlen Canals. (Ueber die Reconstructions-Arbeiten am Rhein-Marne und Saar-Kohlen Canal.) Giving details of the new locks, aqueducts, tunnels and other improvement works on these important waterways of Alsace-Lorraine. 4500 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Aug. 6, 1897. No. 14729 B.

The Chicago Drainage Canal. Frank W. Skinner. Brief reference to the history and conditions that led to the construction of this canal, with statement of the plan and some account of the work. Ill. 3500 w. Eng, Lond—Aug. 6, 1897. Serial. 1st part. No. 14604 A.

The Ottawa Valley Canal. Andrew Bell. Discusses the difficulty of getting deep water on what is called the Lower Ottawa. 900 w. Can Eng—Aug., 1897. No. 14552.

Colombo Harbor.

Colombo Harbor. Editorial discussion of the advantages of this harbor, and of the railway scheme to connect the railway system of Ceylon with that of India. 1200 w. Eng, Lond—Aug. 20, 1897. No. 14935 A.

Dredger.

The Suction Pump Dredger "Octopus" for the Natal Government. Illustrated description. 700 w. Engng—Aug. 20, 1897. No. 14919 A.

Harbor Enterprise.

Harbor Enterprise in South America. Information from an article by R. W. Perks. The docks are described as the largest, newest and best equipped in the American continent. 1800 w. Trans—Aug. 6, 1897. No. 14631 A.

Saving a Town and Cape. George Ethelbert Walsh. Efforts to reduce the danger and prevalence of sand storms at Cape Cod, and to protect Provincetown. 1300 w. Sci Am—Aug. 21, 1897. No. 14670.

The Machinery Plant at the Harbor of La Plata. (Die Maschimeneinrichtung des Hafens von La Plata). Giving an account of the new warehouse plant, with basin, hydraulic cranes, &c., at Ensenada below Buenos Ayres on the La Plata, Argentina, with details of the pumps, accumulators and cranes. Two plates. 3500 w. Zeitschr d ver deutscher Ing—Aug. 7, 1897. No. 14720 B.

The Commercial and Winter Harbor on the Elbe at Riesa. (Der Verkehrs und Winter Hafen an der Elbe.) Description and plan of this important basin and quay wall. 1200 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Aug., 1897. No. 14732 D.

Riparian Rights.

Riparian Rights in Underground Waters. The chief points of a paper by James Mansergh read before the Inst. of Civ. Engs. England, showing the injustice of the old English common law relating to underground waters, when applied to modern conditions, with editorial comment on similar affairs in the United States. 2700 w. Eng News—Aug. 19, 1897. No. 14699.

MISCELLANY.

Catenary.

The Stiffened Catenary. (Die Steife Kettenlinie.) A full analytical and graphical investigation of this most important problem in the subjects of combined resistance to bending and tension. 6000 w. Zeitschr d ver deutscher Ing—July 24, 1897. No. 14716 B.

Constructive Works.

The Paris International Exhibition of 1900. Notes of the preparations, the foundations of the buildings, especially the work for the new bridge over the Seine—the Pont Alexandre III. Ill. 2200 w. Engng—Aug. 20, 1897. No. 14917 A.

Convention.

Transactions of the Council of the Society of

German Engineers at the Cassel Convention. (Versammlung des Vorstandrates des Vereines Deutscher Ingenieure, in Cassel). With reports of committees and transaction of varied business. Two articles, 12000 w. Zeitschr d ver deutscher Ing—July 31, Aug. 7, 1897. No. 14723 E.

Engineering Works.

Notes of a Canadian Journey. Things seen and information collected by the writer, on a journey from Quebec to Duluth, via Halifax, Montreal and Chicago. 5500 w. Eng News—Aug. 26, 1897. Serial. 1st part. No. 14896.

Geodesy.

The Restoration of the Toise of Picard. (Restitution de la Toise de Picard). An interesting note giving the remeasurements of some ancient data in the Paris observatory, restoring the length of the toise of Picard, and making his geodetical measurements comparable with later work. 2500 w. Comptes Rendus—July 26, 1897. No. 14710 B.

Hero of Alexandria.

The First Engineer. W. A. Truesdell. An interesting account of Hero of Alexandria, his labors and their results. 6500 w. Jour Assn of Engng Soc—July, 1897. No. 14622 C.

Masonry Arches.

The Strength and Failure of Masonry Arches. Henry Harrison Suplee. Showing that the laws of elasticity hold good for masonry as for metallic structures. Ill. 3300 w. Eng Mag—Sept., 1897. No. 14898 B.

Steel Construction.

The Use of Steel in the Construction of Dams and Reservoirs. John S. Fielding. Considers steel as the proper material with which to construct a dam or reservoir and discusses the designs. Ill. 2800 w. Can Arch—Aug., 1897. No. 14844 C.

Stone.

See same title under Architecture and Building, Miscellany.

Surveying.

See same title under Mining and Metallurgy, Mining.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

Amazon Exports.

Amazon India-Rubber Exports, First Half of 1897. Shipments from Pará and Manáos. Table. Ind Rub Wld—Aug. 10, 1897. No. 14678 D.

Brazil.

The Trade and Industry of Brazil. Statements regarding the exports, imports, productions, machinery, manufactures, &c. 2000 w. Bd of Trd Jour—Aug., 1897. No. 14878 A.

British Trade.

British Trade and the American Market. Considers the reasons for the outlook for British trade not being encouraging. 900 w. Bradstreet's—Aug. 28, 1897. No. 14910.

Consuls and Trade. Editorial discussion of the diplomatic and consular assistance required, and the suggestions made for the increase of trade. 1700 w. Engng—Aug. 20, 1897. No. 14920 A.

China.

The Promotion of Trade with China. Considers some of the suggestions made by Byron Brenan, for the promotion of trade. 2500 w. Engng—Aug. 13, 1897. No. 14825 A.

Concentration.

Industrial Centralization in Europe. Translation of an article by Henri Blancheville in the *Woolen Industry* of Paris. Calls attention to events occurring abroad, showing the tendency to consolidation, brought about by the necessities of the times. 1500 w. Cons Repts—Aug., 1897. No. 14444 D.

Credit Protection.

German Credit Associations. Explains the object of these associations and how it is accomplished, and gives general information of the system. 2500 w. Cons Repts—Aug., 1897. No. 14443 D.

Export Iron.

See same title under Mining and Metallurgy, Iron and Steel.

Import Duties.

The Dingley Law. Copy of the tariff act approved July 24, 1897. 47200 w. Bureau of Am Reps Bul. 75—July, 1897. No. 14441 D.

Industries.

The Distribution of Industries. A. Humboldt Sexton. Discusses the distribution of the various great industries over the United Kingdom, the conditions which determined their localization, and the probabilities of changes through the influence of changed conditions. 2500 w. Prac Eng—Aug. 13, 1897. No. 14850 A.

Japan.

The Foreign Trade of Japan in 1896. Information from the report drawn by Mr. Lay, acting vice-consul at Tokio, on the trade for 1896, showing a decided advance. 1800 w. Engng—July 30, 1897. No. 14507 A.

Panama.

Competition with British Trade at Panama. Reviews causes that tend to place the British manufacturer at a disadvantage, and comparing items of British origin with those of other countries. 1400 w. Bd of Trd Jour—Aug., 1897. No. 14877 A.

Prices.

A German View of Prices of Rubber Goods. From the "Gummi Zeitung." Thinks the only alternative is for manufacturers to estimate on higher selling-prices within the near future. 700 w. Ind Rub Wld—Aug. 10, 1897. No. 14676 D.

Comparative Prices of 108 Staple Articles, Raw and Manufactured Products, Produce, Cattle, and Meats, at Quarterly and Monthly Intervals, Showing Fluctuations in Quotations from July 1, 1892, to August 1, 1897, Covering the Period of Recent Extreme Depression. Table. Bradstreet's—Aug. 14, 1897. No. 14614.

Protection.

British Industries Developed by Protection. Historical review of legislation in England for the protection of manufactures. 4200 w. Bul of Am Ir & St Assn—Aug. 20, 1897. No. 14808.

Railroad Supplies.

The Railroads as Buyers of Supplies. Editorial summary of replies received from branches of the supply trade showing a fairly hopeful outlook. 2000 w. R R Gaz—Aug. 20, 1897. No. 14806.

Tariff.

Features of the New Tariff They Object To. Report of protests made by foreign countries to certain features of the new tariff. 600 w. Age of St—Aug. 7, 1897. No. 14500.

India-Rubber Goods in the New Tariff Law. A comparison with previous rates of duties. The rates are usually higher than under the law of 1894, but lower than under the McKinley law. 1000 w. Ind Rub Wld—Aug. 10, 1897. No. 15677 D.

New Customs Tariff of Canada. Schedules A, B, and C of the New Customs Tariff. 5000 w. Bd of Trd Jour—Aug., 1897. Serial. 1st part. No. 14879 A.

Tariff Changes and Customs Regulations. Sweden and Norway, Belgium, Netherlands, Germany, France, Portugal, Spain, Italy, United States, United States of Colombia, Venezuela, Morocco, British India, British Honduras, Barbadoes, and Montserrat. 4500 w. Bd of Trd Jour—Aug., 1897. No. 14880 A.

The New Metal Tariff. A copy of the new Canadian tariff affecting the iron and other metal trades, and including building material. 5000 w. Can Eng—Aug., 1897. No. 14554,

Trade Disputes.

First Proceedings under the Conciliation (Trade Disputes) Act. Comment on the report lately issued by the Board of Trade, with discussion of its utility. 1500 w. Jour Gas Lgt—Aug. 10, 1897. No. 14683 A.

World's Trade.

Twenty Years of Trade. Michael G. Mulhall. A survey of the world's trade for the past twenty years, comparing the growth of British commerce at decennial periods with that of other countries. 1400 w. Contemporary Rev—Aug., 7, 1897. No. 14588 D.

CURRENCY AND FINANCE.

Currency Reform.

Obstacles to Currency Reform. Carl Schurz. Considers the main obstacle to be cowardice of the politicians. 1600 w. Harper's Wk—Aug., 1897. No. 14425.

The Business Revival and Currency Reform. Evidences of reviving business and the probable effects on financial legislation are discussed. 1800 w. Banker's Mag, N. Y.—Aug., 1897. No. 14620 D.

Financial Situation.

A Review of the Financial Situation. Mentions the favorable conditions recently developed, and the many indications of activity and prosperity. 4000 w. Bankers' Mag, N. Y.—Aug., 1897. No. 14621 D.

Japan.

Japanese Industrial Finance. Editorial on an article in the *Japan Weekly Mail*, giving details of many of the most important proposals for the next few years, and making an interesting comparison of the financial condition of Japan with that of some of the leading European countries. 1800 w. Engng—Aug. 6, 1897. No. 14610 A.

LABOR.

Accidents.

Compensation for Accidents. Editorial on the effects of the Workmen's Compensation for Accidents Act. 1600 w. Eng, Lond—Aug. 20, 1897. No. 14936 A.

The Workmen's Compensation Act. Explanatory notes prepared by Thomas Ratcliffe Ellis. 9000 w. Col Guard—Aug. 20, 1897. No. 14931 A.

Capital and Labor.

Another Step in Promoting the Union of Capital and Labor. George Livesey. Read before the Incorporated Inst. of Gas Engs. In part first the present position is considered, and the advisability of making the worker a shareholder is discussed. The question is confined to the gas industry. 2800 w. Gas Engs Mag—Aug. 10, 1897. Serial. 1st part. No. 14859 A.

Eight-Hour Day.

The Struggle in the Engineering Industries. An appeal of the English employers to the general engineering industries of the country. 1200 w. Ir & Coal Trds Rev—July 30, 1897. No. 14522 A.

Electrical Regulations.

The Electrical Regulations of the Home Office. Editorial consideration of the Report of the Departmental Committee, for the protection of those engaged in the electrical industries. 3500 w. Elec Rev, Lond—July 30, 1897. No. 14511 A.

Strikes.

Lessons of the Great Engineering Strike in England. J. Stephen Jeans. Criticising the trade union attitude toward piece-work, apprentices, and machine tools. 4700 w. Eng Mag—Sept., 1897. No. 14897 B.

The Bituminous-Coal Strike. Some reference to the difficulties in the situation. 800 w. Bradstreet's—Aug. 28, 1897. No. 14909.

Unions.

Organization and Benefits of Trade Unions. Editorial explanation of the working of the great trade unions of England, especially those engaged in the engineering struggle. 1800 w. Engng—July 30, 1897. No. 14506 A.

Workers.

Workers at Gainful Occupations at the Federal Censuses of 1870, 1880, and 1890. William C. Hunt. Discussion of the classifications given in the census reports, showing a perceptible increase in the proportion of persons engaged in the higher grades of work. 11700 w. Bul of Dept of Labor—July, 1897. No. 14479 D.

MISCELLANY.

Madagascar.

The Economic Condition of Madagascar. A statement of prevailing conditions, public works, trade, productions, &c. 2500 w. Bd of Trd Jour—Aug., 1897. No. 14876 A.

Newfoundland Resources.

To Europe by Steamer in Three Days. Comment on an article by Dr. Wilfrid Grenfell, in the Toronto *Globe*, pointing out matters of interest concerning the mineral and other advantages of the province, and the facilities for traffic with not much more than a three days journey by water. 1000 w. Bradstreet's—Aug. 28, 1897. No. 14908.

Russia.

The Iron Industry of Southern Russia. (Die Eisenindustrie in Südrussland.) Giving commercial data as to production revenue and other statistics. 4000 w. Stahl und Eisen—July 1, 1897. No. 14748 D.

Social Conditions.

Are the Rich Growing Richer and the Poor Poorer? Carroll D. Wright. An interesting paper showing the falseness of the assertion and its misleading influence. 6000 w. Atlantic M —Sept., 1897. No. 14680 D.

Wheat and Silver.

Wheat Up, Silver Down—Facts. Wharton Barker, in *The American*. A consideration of the conditions of the past and present, from the view of a bimetallist. 2500 w. Min Ind & Rev—Aug. 19, 1897. No. 14858.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Bronze.

The Analysis of Bronzes by Electrolysis. (Analyse des Bronzes par l'Electrolyse.) The method of Holland, in which the various constituents are separated by electric deposition with ease and accuracy. 2000 w. La Revue Technique—July 25, 1897. No. 14701 D.

Colloids.

The Electrical Transfer of Colloids. (Ueber Elektrische Wanderung von Colloiden.) A discussion of the influence of electrical currents upon phenomena of diffusion by Dr. Coehn. 2000 w. Zeitschr f Elektrochemie—July 20, 1897. No. 14771 B.

Electro-Chemistry.

The First Principles of Electro-Chemistry. W. W. Haldane Gee. The first of a series of articles relating to the fundamental principles. 1200 w. Elec, Lond—Aug. 20, 1897. Serial. 1st part. No. 14911 A.

Electrolysis.

The Automatic Electrolytic Recording of Electric Currents. (Die Selbstaufzeichnung Elektrischer Ströme auf Elektrolytischem Wege.) Discussing the various methods of recording the strength, frequency, interruptions, &c., of electric currents by the electrolytic action upon suitably prepared paper ribbons. 9000 w. Elektrochemische Zeitschr—August, 1897. No. 14776 B.

Europe.

Electro-Chemical and Electro-Metallurgical Industries of Europe. John B. C. Kershaw. The first of a series of articles dealing with the development of these industries. A rapid survey will be given, with detailed account of those processes which have attained greater development abroad than in the United States, &c. 1800 w. Elec—Aug. 11, 1897. Serial. 1st part. No. 14615.

Laboratory.

The Electrochemical Laboratory at the Royal Technical High School at Munich. (Elektrochemischen Laboratoriums der Kgl. Bayr. Technischen Hochschule München.) A full description of this fine laboratory with numerous illustrations. 3000 w. 3 plates. Zeitschr f Elektrochemie—July 20, 1897. No. 14774 B.

Organic Chemistry.

The Relations of Electrochemistry to Organic Chemistry. (Ueber die Beziehungen der Elektrochemie zur Organischen Chemie.) Showing the numerous applications of electrochemistry to organic analysis and synthesis. 4500 w. Zeitschr f Elektrochemie—Aug. 5, 1897. No. 14775 B.

Synthesis.

The Synthesis of Organic Acids. (Ueber Synthese von Organischen Säuren.) A paper by Dr. von Miller, discussing the production of organic acids synthetically by use of the electric current. 2000 w. Zeitschr f Elektrochemie—July 20, 1897. No. 14769 B.

Transformation.

An Electrochemical Method of Transforming Alternating into Continuous Currents. (Ueber eine Electro-Chemisches Verfahren um Wechselströme in Gleichströme zu Verwandeln.) The transformation is effected by utilization of the polarizing properties of aluminum. 2500 w. Zeitschr f Elektrochemie—July 20, 1897. No. 14772 B.

LIGHTING.

Arcs.

A Curious Alternate-Current Arc Phenomenon. Alfred Hay. Remarkable phenomenon observed in the course of some experiments on alternate-current arcs between metallic electrodes. 800 w. Elect'n—Aug. 13, 1897. No. 14840 A.

The Phenomena of the Electric Arc. (Sur le Phénomène de l'Arc Électrique.) An account of experimental investigations of M. Blondel to determine the magnitude and nature of the resistance of the electric arc. 2000 w. Comptes Rendus—July 19, 1897. No. 14708 B.

Buffalo, N. Y.

Electric Lighting Progress in Buffalo, N. Y. Report of extensions being made which will make this city one of the best lighted in the United States. 1000 w. Elec Rev—Aug. 18, 1897. No. 14665.

Combination.

See same title under Power.

Compound Engines.

See same title under Mechanical Engineering, Engines and Motors.

Condensers.

The Employment of Condensers in Alternate Current Arc Lamps. George Claude. A new use for condensers is described, to improve the regulation of alternating current arc lamps. Past failures are explained. From *L'Industrie Electrique*. 1500 w. Elect'n—Aug. 6, 1897. No. 14633 A.

Electric Fountain.

The Electric Fountain at the Prospect Park Plaza, Brooklyn, N. Y. Illustrated detailed description of the fountain and its operation. 1800 w. Elec Eng—Aug. 19, 1897. No. 14668.

Fittings.

The Design of Electric Light and Gas Fittings. Criticism of an article published in *Lightning*, on the adaptation of electric lamps to decoration as well as illumination of domestic interiors. 1800 w. Jour Gas Lgt—July 27, 1897. No. 14491 A.

Fleet Illumination.

How the Fleet at Spithead Was Illuminated. Describes the methods adopted in securing the desired end, with a copy of the admiralty instructions. 900 w. Eng, Lond—July 30, 1897. No. 14515 A.

Garbage.

Garbage as a Fuel for Electric Light Stations. A discussion of this subject suggested by the recent installation at Shoreditch, London, setting forth some of the reasons why the success of the plan is very problematical in England and still more doubtful in America. 2000 w. Eng News—Aug. 26, 1897. No. 14895.

Gas Engines.

Failures of Gas Engines at Electric Lighting Stations. Gives records of failures, considering them more instructive than records of success. Three of the failures were recently recorded in the London *Electrician*, namely at Belfast, Morecambe, and at Coatbridge. 1200 w. Eng News—Aug. 26, 1897. No. 14893.

Isolated Plant.

An Interesting Isolated Plant at Yokohoma, Japan. Lamar Lyndon. Illustrated description of a private plant for lighting a tea factory. 2400 w. Elec Eng—Aug. 26, 1897. No. 14860.

Isolated Electric Plants versus Central Stations. Percival Robert Moses. Showing that the private plant is more economical in large installations where the load is continuous. 3700 w. Eng Mag—Sept., 1897. Serial. 2d part. No. 14900 B.

Public Lighting.

Theory of Public Lighting. Andre Blondel. From *La Genie Civil.* Discusses the use of electric lamps, the position in which they should be placed to obtain the best effect, &c. 1800 w. Ind & East Eng—July 3, 1897. Serial. 1st part. No. 14492 D.

Rectifiers.

Rectifiers for Arc Lighting. Describes an apparatus put into commercial use in England, for supplying direct current to high tension series arc circuits from a regular alternating-current dynamo. Ill. 900 w. Elec Wld—Aug. 21, 1897. No. 14845.

Small Districts.

The Lighting of Small Districts. F. J. Warden-Stevens. Discusses the conditions affecting the lighting of small districts in England, and recommends electric lighting. 2000 w. Arch, Lond—July 30, 1897. No. 14550 A.

Theatre Lighting.

The Grand Theatre, Fulham. Illustrated description of the electric lighting arrangements. 1800 w. Elec Eng, Lond—Aug. 20, 1897. No. 14948 A.

Voltmeters.

The Voltmeter in Series Arc Stations. Alex Dow. Discusses the various uses to which a voltmeter can profitably be put in a series arc lighting station. 4400 w. Elec Engng—Aug. 1, 1897. No. 14543.

Wiring.

Electric Wiring. F. J. Warden-Stevens. Reviews the progress made in methods of wiring, considering various systems in detail, and comparing them with the conditions of a perfect system. 2500 w. Arch, Lond—Aug. 13, 1897. No. 14841 A.

Interior Wiring. Editorial discussion of the wiring rules of the Institution of Electrical Engineers. 3000 w. Elec Rev, Lond—Aug. 20, 1897. No. 14942 A.

Wiring Rules. General rules for wiring, issued by the Institution of Electrical Engineers, confined to a statement of requirements. 4800 w. Elec Eng, Lond—Aug. 13, 1897. No. 14822.

POWER.

Accident.

The Accident at the Paterson Station. Illustrated description of a singular accident in the Edison generating station at Paterson, N. J. 400 w. Elec Wld—Aug. 21, 1897. No. 14846.

Accumulators.

Quick-Charge Accumulators. M. Blanchon. Read before the Société Internationale des Electriciens. Describes the construction of the Tudor accumulator, showing what constitutes a "quick-charge" accumulator, considers the services it can render for electric traction, &c. 6000 w. Elect'n—Aug. 20, 1897. No. 14941 A.

The Computation of the Capacity of a Lead Accumulator under Variable Current. (Ueber die Berechnung der Kapazität eines Bleiakkumulators be Variabeler Stromstärke.) A mathematical discussion by Herr Liebenow. 3500 w. Zeitschr f Elektrochemie—July 20, 1897. No. 14770 B.

Traction Accumulators—Law of Maximum Work. Law of Maximum Useful Work. Desmond G. Fitz-Gerald. The opinions of the writer, with reasons. 1200 w. Elec Eng, Lond—Aug. 20, 1897. No. 14946 A.

Armatures.

On Toothed Armatures. Michael v. Dolivo-Dobrowolsky. From the *Elektrotechnische Zeitschrift.* Considers a few matters needing explanation, in the belief that putting them straight will be of value and importance. 1800 w. Elec Eng, Lond—Aug. 6, 1897. No. 14596 A.

See same title under Mechanical Engineering, Shop and Foundry.

Some Remarks on Slot and Tunnel Armatures. M. von Dolivo-Dobrowolsky. From the *Elektrotechnische Zeitschrift.* Explanation of peculiarities and facts not generally understood. Ill. 1500 w. Elect'n—Aug. 20, 1897. No. 14938 A.

Automobiles.

See same title under Mechanical Engineering, Miscellany.

Battery.

A Gas Carbon Element. (Ueber ein Kohlen-Gas Element.) A new carbon element consisting of carbon and copper electrodes in a solution of salammoniac or a metallic salt, traversed by a stream of carbonic oxide. 7500 w. Zeitschr f Elektrochemie—July 20, 1897. No. 14768 B.

Combination.

Combined Lighting and Traction. Andrew Stewart. Notes on combined lighting and traction systems showing them to be both profitable and economical. 1800 w. Elec, Lond—July 30, 1897. No. 14501 A.

Cranes.

Cranes with Electric Motive Power. (Ueber einige Hebe-Apparate mit Elektrischem Antrieb.) Describing and illustrating the electric traveling and locomotive cranes and hoists built by the Oerlikon Works. 5000 w. Schweizerische Bauzeitung—Aug. 7, 1897. No. 14766 B.

Dynamos.

Dynamo Design. Albert W. Smith. Proposes a design that overcomes some of the objectionable features of the usual type. 1500 w. Elec Eng—Aug. 12, 1897. No. 14561.

Electric Mining.

See same title under Mining and Metallurgy, Mining.

Electric Plants.

The Construction of Electric Plants in View of Future Tramway Service. (Wie Soll Man Elektricitäts Werke Bauen um von Ihnen auch die Strassenbahnen treiben zu Können?) A discussion of a problem of frequent occurrence in Germany and elsewhere, with suggestive details. 2000 w. Deutsche Zeitschr f Elektrotechnik—July 15, 1897. No. 14781 B.

Elevators.

Electric Elevator Problems and Some of Their Solutions. J. E. Woodbridge. Discusses the reasons for the increased economy of power of the electric elevator over the hydraulic, the difficulties encountered in elevator service, the Leonard system and its disadvantages, &c. 3500 w. Elec Wld—Aug. 7, 1897. No. 14537.

Motors and Details for Electric Elevators. (Motoren und Hülfsapparate für elektrisch betriebene Hebezeuge.) Discussing the best forms of motors, regulators, controlling apparatus, &c., with numerous diagrams. Serial, 2 articles. 12000 w. Zeitschr d Ver deutscher Ing—July 3, Aug. 7, 1897. No. 14721 E.

Passenger Elevators. (Ueber Personenaufzüge.) A discussion of the best arrangement of passenger elevators, as to location in building as well as motive power, with plate of details of hydraulic and electric elevators. 7000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—July 23, 1897. No. 14725 B.

Failures.

Causes of Failure in Electrical Plant. Sydney F. Walker. Considers the causes by means of which an electrical apparatus either refuses to do its proper work at all or does it imperfectly. 3200 w. Col Guard—Aug. 20, 1897. No. 14927 A.

Haulage.

See same title under Marine Engineering.

Instantaneous Voltage.

Diagrams of Instantaneous Voltage in Alternate Current Circuits. H. N. Allen. Describes method of obtaining a clear idea of the variation of potential throughout the circuit. The instantaneous voltages, for any moment during the period, are plotted as ordinates and the impedances of the circuit as abscissae. 1600 w. Elect'n—Aug. 20, 1897. No. 14940 A.

Machine Driving.

Electric Motors at the Ramapo Iron Works. An account of the introduction of small electric motors for driving machinery. 1000 w. R R Gaz—Aug. 20, 1897. No. 14803.

Niagara Power.

Lord Kelvin and the Niagara Power Transmission. Orrin E. Dunlop. An account of an interview on the occasion of Lord Kelvin's recent visit. Ill. 1600 w. Elec Eng—Aug. 26, 1897. No. 14861.

Plows.

Electrically Driven Plows. (Elektrisch Betriebene Pflüge.) Describing especially the Zimmermann system, with gang plow hauled by a chain operated by electric motor mounted on the plow. Two articles. 7000 w. Die Elektrizität —July 17 & 31, 1897. No. 14785 D.

Potentiometer.

A Wide Range Potentiometer. L. H. Fry. Describes a potentiometer designed by Herr Thiermann of the Hanover Polytechnikum, devised especially for the calibration of voltmeters, but which is also adapted for all current and resistance measurements. 1200 w. Elec Rev, Lond—Aug. 20, 1897. No. 14943 A.

Station.

A German Three-Phase Central Station. Illustrated detailed description of the plant at Strassburg, Germany. 5400 w. Am Elect'n—Sept., 1897. No. 14953.

Windsor Electricity Works. Illustrated detailed description of works and equipment. 3300 w. Elec Eng, Lond—July 30, 1897. No. 14510 A.

St. Lawrence River.

Electric Power from the St. Lawrence River. Details concerning an important project near Massena, N. Y. Ill. 3000 w. Elec Rev—Aug. 4, 1897. No. 14464.

The Massena Water-Power Electrical Generating Plant. Brief illustrated description of some of the important features. 500 w. Am Elect'n—Sept., 1897. No. 14954.

Transformers.

The Predetermination of the Regulation of a Transformer with Non-Inductive Load. F. Bedell, R. E. Chandler, and R. H. Sherwood, Jr. Presented at the Detroit meeting of the Am. Assn. for the Advancement of Science. Gives a method for determining the exact regulation of a transformer without the necessity of applying a load. 2300 w. Elec Wld—Aug. 14, 1897. No. 14630.

Water Power.

Hydro-Electric Power Stations in the United States. Part first gives information of the plant at St. Anthony's Falls. 1000 w. Elec Rev, Lond—Aug. 6, 1897. Serial. 1st part. No. 14625 A.

TELEGRAPHY AND TELEPHONY.

Cables.

The Limits of Speed in Working Submarine Cables as Affected by Faults or Leaks, and by the Proportions of the Materials. W. A. Price. Determines, by calculation, the effect of such faults on the signalling. 2200 w. Elec Rev, Lond—Aug. 6, 1897. No. 14627 A.

Exchange.

The Strowger Automatic Telephone Exchange, at Amsterdam, N. Y. Illustrated description of a plant of the latest type. 1700 w. Elec Eng—Aug. 12, 1897. No. 14560.

The Strowger Automatic Telephone Exchange, Augusta, Ga. Illustrated description of what is said to be the largest automatic telephone exchange in the world. 1500 w. Elec Eng—Aug. 5, 1897. No. 14466.

Gilgit Telegraph Line.

An Incident in the Working of the Gilgit Telegraph Line. Extract from the *Electrician.* An interesting account of adventure and heroism on the part of Indian telegraph department officials and native staff. 1600 w. Ind & East Eng—July 24, 1897. No. 14881 D.

High-Speed Telegraphy.

High-Speed Telegraphy in Connection with an Alaska-Russian Telegraph Line. Reginald A. Fessenden. Discusses the value of a telegraph line through Alaska, stating the circumstances which in the writer's opinion favor the construction. 1300 w. Elec Wld—Aug. 7, 1897. No. 14534.

MISCELLANY.

Alternating Currents.

New Optical Method of Studying Alternating Currents. (Nouvelle Methode Optique d'Etude des Courants Alternatifs.) Describing an improvement in the strobosopic method of M. Pionchon, devised by MM. Abraham and Buisson. 120 w. Comptes Rendus—July 12, 1897. No. 14705 B.

Aluminum.

Aluminum as a Material for Electrical Conductors. (Ueber Aluminum als Leitungs Material.) A discussion of the relations between weight, conductivity and cost, which may render aluminum conductors practicable. 1200 w. Deutsche Zeitschr f Elektrotechnik—July 15, 1897. No. 14779 B.

Circuit Breakers.

I. The Fuse and the Circuit Breaker. W. M. Stine. II. Circuit Breakers vs. Fuses. T. W. Bevan. Two articles in defense of circuit breakers. 2000 w. Am Elect'n—Sept., 1897. No. 14955.

Coil Experiments.

Interesting Information on Tesla Coil Experiments. Elliott Woods. The results of the writer's experience are given. 900 w. Elec Rev—Aug. 18, 1897. No. 14667.

Conduit Construction.

Conduit Construction in St. Louis. Frank Clark Cosby. An account of the work of placing wires under ground. The various wire-using companies have selected various styles of conduits, thus giving an opportunity of comparing work under the same conditions, but involving nearly all types of conduit in the market. Ill. 1800 w. Elec Wld—Aug. 21, 1897. Serial. 1st part. No. 14847.

Dangers.

Dangers Connected with the Supply of Electricity. From the report of the committee appointed by the Home Office. 1700 w. Arch, Lond—Aug. 6, 1897. No. 14645 A.

Diamagnetic Substances.

Researches in Diamagnetic and Feebly-Magnetic Substances. Luigi Lombardi. Investigations at the Federal Polytechnic of Zurich. The research is chiefly confined to solid diamagnetic bodies, and the results show clearly the absence of hysteresis. 2400 w. Elect'n—Aug. 6, 1897. No. 14634 A.

Electrical Code.

The National Electrical Code. Part first begins an outline of the evolution of electrical rules from the beginnings to the present time. 2400 w. Elec Rev—Aug. 18, 1897. Serial. 1st part. No. 14666.

Electrical Cooking.

The Economy and Utility of Electrical Cooking Apparatus. John Price Jackson. Describes tests made with the hope of obtaining a method of cooking that would be satisfactory with a minimum risk of fire. Results showing the cost of cooking by coal to be about 19% of the cost by electricity. 1500 w. Elec Wld—July 31, 1897. No. 14451.

Electric Furnace.

The Electric Furnace. F. Jarvis Patten. Part first is mostly historical with illustrations of the earliest patents. 1200 w. Elec Eng—Aug. 12, 1897. Serial. 1st part. No. 14559.

Electrical Regulations.

See same title under Economics and Trade, Labor.

Electricity.

Electricity During the Last Five Years. Franz Bendt. Translated from the German *Ueber Land und Meer.* Reviews briefly the history of the science and the most recent advances. 2200 w. Chau—Sept., 1897. No. 14961 C.

Electricity and Magnetism.

A Course of Reading on Electricity and Magnetism. F. A. C. Perrine. Points out a course of reading for a student who wishes to lay a firm foundation for a working knowledge of engineering. 2000 w. Elec Engng—Aug. 15, 1897. No. 14883.

Electric Heat.

The Use of Electric Heat in the Manufacture of Hats. Illustrated description of the electrically treated ironing appliances as adopted in the factory of Budish & Yudizky, of Newark, N. J. 1400 w. Elec Wld—July 31, 1897. No. 14450.

Galvanometer.

The Ballistic Galvanometer in Theory and Practice. Ellis H. Crapper. The first of a series of articles on experimental work with this instrument. Defines and explains the theory. Ill. 1500 w. Elec Eng, Lond—Aug. 20, 1897. Serial. 1st part. No. 14947 A.

India-Rubber.

Substitutes for India-Rubber. H. L. Terry. Discusses this subject, pointing out the danger with which users of India-rubber for electrical purposes are threatened. 2000 w. Elect'n—Aug. 6, 1897. No. 14632 A.

Induction.

Induction in Short Soft Iron Magnets. H. O. Eurich. A short summary of results obtained. in a series of experiments at the Electrical laboratory of the Yorkshire College, Leeds. 600 w. Elec Rev, Lond—Aug. 6, 1897. No. 14626 A.

Lightning.

Improvements in Lightning Conductors. (Vereinfachung der Gebaüdeblitzableiter.) A very full discussion before the Electrotechnical Society. 20000 w. Electrotech Zeitschr—Aug. 5, 1897. No. 14789 B.

Meters.

Perfected Clockwork Electric Meter. (Vervoll Kommneter Uhrenzähler.) Aron's Improved electric meter, operates by the electric control of a clockwork escapement system. 4500 w. Electrotech Zeitschr—July 1, 1897. No. 14786 B.

The Meters of To-day. R. F. Schuchardt. Read at meeting of the Northwestern Electrical Assn. Investigations show that meters are not all that might be desired. Points to be considered in selecting a meter are given. 1600 w. Elec Wld—July 31, 1897. No. 14452.

Titration.

A Galvanometric Method of Titration. (Ueber eine Galvanometrische Titrier Methode.) A paper by Dr. Salomon showing the applicability of the method of measuring electric currents to the solution of problems in volumetric analysis. 2000 w. Zeitsch f Elektrochemie—July 20, 1897. No. 14773 B.

X-Rays.

Endoscopy. G. Brunel, in *La Revue des Revues.* An account of numerous and beneficial applications of the X-rays. 1800 w. Sci Am Sup—Aug. 14, 1897. No. 14569.

Tesla on the Source of Roentgen Rays and the Practical Construction and Safe Operation of Lenard Tubes. Nikola Tesla. Illustrated account of the writer's investigations and report of results. 3500 w. Elec Rev—Aug. 11, 1897. No. 14556.

The Action of X-Rays, &c. (De l'Action des Rayons X, &c.) Three Papers before the French Academy discussing experimental researches, chiefly relating to the use of X-rays for investigating flaws in metals. 2500 w. Comptes Rendus—July 19, 1897. No. 14709 B.

The Transformation of X-Rays by Metals. (Sur la Transformation des Rayons X par les Métaux.) A note presented to the French Academy by M. Sagnac, showing feeble reflections and other phenomena effected by certain metals. 1200 w. Comptes Rendus—July 26, 1897. No. 14713 B.

The X-Rays in the Custom House. Brief explanation of the method, with illustrations. 1800 w. Sci Am—Aug. 7, 1897. No. 14470.

Underground Mains.

The Localization of Faults in Underground Mains. Robert C. Quinn. Read before the Municipal Electrical Assn., at Manchester, Eng. Results from the large experience of the writer, methods used and the reasons why he adopted the final method. Discussion and illustrations, with editorial. 6500 w. Elect'n—July 30, 1897. No. 14524 A.

MARINE ENGINEERING.

Armor.

Hardened Plates and Broken Projectiles. L. E. Bertin. Read at the International Congress of Naval Architects and Marine Engineers. On Harveyed plates, their trials, &c. Part first presents a summary analysis of Mr. Ellis' tables, contained in a study of the American Navy. A study of the penetration. 3000 w. Engng—July 30, 1897. Serial. 1st part. No. 14508 A.

Battle-Ship.

Contract Trial of the United States Sea-Going Battle-ship, Iowa. J. M. Pickrell. Illustrated detailed description of the vessel and its equipment with report of speed trial. 8400 w. Jour Am Soc of Nav Engs—Aug., 1897. No. 14481 H.

Docks.

Manchester Ship Canal Dock Warehouses. Illustrates and describes two of the blocks of warehouses erected by the Ship Canal Warehouseing Co., Limited. General plan is given. 1400 w. Eng, Lond—July 30, 1897. No. 14516 A.

Repairs to Dry Dock No. 3 at the Brooklyn Navy Yard. Brief general description of the work. 600 w. Sci Am—Aug. 28, 1897. No. 14862.

Electrical Equipment.

Electricity on the Steamship "Bremen." Illustrated description of a vessel of the North German Lloyd line, which is said to be more fully equipped electrically, than any other vessel of the merchant marine. 900 w. Ir Age—Aug. 5, 1897. No. 14437.

Engineering.

The Future of Engineering in the Navy. Reviews some of the changes that would improve the smooth running of the engineering department of a ship. 2800 w. Ir Age—Aug. 5, 1897. No. 14440.

Gunboats.

Contract Trial of the U. S. S. Nashville. W. Strother Smith and C. B. Price. Illustrated description of vessel, furnishings and equipment, with data of trial. 4300 w. Jour Am Soc of Nav Engs—Aug., 1897. No. 14486 H.

The Contract Trial of the U. S. Gunboat Annapolis. C. H. Mathews. Illustrated detailed description with data of trial. 2500 w. Jour Am Soc of Nav Engs—Aug., 1897. No. 14484 H.

The Contract Trials of the U. S. Gunboats Vicksburg and Newport. H. N. Stevenson. Description, with principal dimensions of engine and account of trials. Ill. 2500 w. Jour Am Soc of Nav Engs—Aug., 1897. No. 14483 H.

Haulage.

The Electric Traction of Boats. (La Traction Electrique des Bateaux.) An illustrated account of the Denèfle system of electric trolley haulage for canal boats now being tested on several French canals. 1 plate. 2500 w. La Revue Technique—July 25, 1897. No. 14700 D.

Inland Navigation.

Inland Navigation in the United States. Extracts from a paper by Smith S. Leach, presented to the Inst. of Civ. Engs. A brief summary of the extent of inland navigation in this country. 500 w. Eng News—Aug. 19, 1897. No. 14697.

Lighthouses.

Lighthouse Illumination in Japan. C. S. Du Riche Preller. Illustrated description of the salient features of the new Japanese light, erected in the Island of Formosa. Lightning flash apparatus. 1400 w. Engng—July 30, 1897. No. 14503 A.

Marine Engineering.

Fifty Years of Advance in Marine Engineering. Ridgely Hunt. Showing the increase, since 1840, in horse-power, steam pressure, tonnage, speed, etc. Ill. 4500 w. Eng Mag—Sept., 1897. No. 14901 B.

Marine Engines.

Modern Improvements in Marine Engine Practice. Editorial on paper by Messrs. A. J. Durston, and J. T. Milton, reviewing recent improvements and commenting on future prospects. 2200 w. Eng News—Aug. 5, 1897. No. 14487.

Rotary vs. Reciprocating Marine Engines. Charles Algernon Parsons. Presents the relative advantages and disadvantages of rotary and reciprocating engines as applied to ship propulsion. Read at the Inst. of Civ. Engs—Engineering Conference. Ill. 1500 w. Jour Am Soc of Nav Engs—Aug., 1897. No. 14485 H.

The Jubilee of Messrs. A. and J. Inglis. A review of the work of this firm, with illustrations of the paddle engines of the old tugboat Clyde, built 47 years ago and still doing duty. 2300 w. Engng—July 30, 1897. No. 14505 A.

Mercantile Marine.

The French Mercantile Marine. Editorial review of the conditions in France causing the decadence of the mercantile marine. 1800 w. Eng, Lond—Aug. 13, 1897. No. 14834 A.

Monitors.

Reconstructed American Monitors. F. M. Bennett. The history of the Puritan is given as an example of the class, experience in a reconstructed monitor related, and the means by which the worst faults were corrected, with much other information. 9500 w. Jour Am Soc of Nav Engs—Aug., 1897. No. 14482 H.

Newfoundland Resources.

See same title under Economics and Industry, Miscellany.

Princess Anne.

Latest Addition to the Fleet of the Old Dominion Steamship Co. Illustrated description of a fine coast line vessel. 2000 w. Marine Engng—Aug., 1897. No. 14557 C.

Propeller.

The Sheathed Propeller. Describes a small propeller of peculiar construction, lately put on the market by the Sheathing Propeller Company of London. Ill. 800 w. Sci Am Sup—Aug. 7, 1897. No. 14473.

Pumping.

Recent Improvements in Pumping Machinery for Marine Service. John A. Drew. Read at meeting of Consolidated Association of Marine Engineers. History of the direct-acting steam pump. Ill. 3000 w. Steamship—Aug., 1897. No. 14496 A.

Safety.

Life Saving Appliances. (Les Moyens de Sauvetage.) Giving the text of the new French law providing for life saving appliances at sea, with discussion, by M. Dibos. 3500 w. La Revue Technique—July 25, 1897. No. 14703 D.

Signalling Gear.

Multiphase Signalling Gear. C. Arldt. Abstract of a paper read at the Eisenach meeting of the Verband Deutscher Elektrotechniker. Illustrated description of instruments used at water works, on board vessels, &c. 1000 w. Elec Eng, Lond—Aug. 20, 1897. No. 14949 A.

Spithead.

Naval Review at Spithead in Honor of Queen Victoria's Jubilee. John D. Ford. Interesting account of the naval vessels and incidents of the review, by the chief engineer of the U. S. S. Brooklyn. 3300 w. Marine Engng—Aug., 1897. No. 14558 C.

Steamboat.

The Danube River Side-Wheel Steamboat "Francis Joseph I." Illustrated description of an interesting example of foreign practice. 900 w. Eng News—Aug. 26, 1897. No. 14894.

The Danube Steamer "Francis Joseph I." (Der Donaudampfer "I. Ferencz Jozsef.") Full details of this fine new river steamer, with drawings of boilers, engines and hull. 2 plates. 3000 w. Zeitschr d ver deutscher Ing—July 24, 1897. No. 14715 B.

Submarine Vessels.

Submarine Vessels. A description of the "Plunger" recently launched at Baltimore, as given in the *Baltimore Sun.* 2300 w. Eng—Aug. 21, 1897. No. 14866.

Water-Tube Boilers.

Water-Tube Boilers in High-Speed Ocean Steamers. P. Sigaudy. Paper submitted at the International Congress of Naval Architects and Marine Engineers. Claiming that the next important step in ocean steam navigation will be the adoption of the water-tube boiler. 1500 w. Steamship—Aug., 1897. No. 14497 A.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Boilers,

Installation of Boilers. (Aufstellung von Dampfkesseln.) The official rules of the Prussian Government covering the details of steam boiler installation, as revised June 30, 1897. 2500 w. Zeitschr d ver deutscher Ing—Aug. 7, 1897. No. 14724 B.

The Dubian Improvements in Steam Boiler Construction. (Die Neuen Dampfkessel mit Dubian's cher Emulsions-Einrichtung.) Describing the Dubian emulsion tubes as connected to boilers of various designs, for the improvement in the circulation and the prevention of foaming. 6000 w. Zeitschr d Oesterr Ing u Arch ver—July 30, 1897. No. 14727 B.

The Proportions of Locomotive Boilers. Editorial criticism of the investigations on the proper ratio of heating surface and grate area to cylinder volume for passenger and freight engines, made by the committee of the American Ry. Mas. Mech. Ass'n. 1600 w. Eng, Lond—Aug. 20, 1897. No. 14934 A.

Uniform American Boiler Specifications. E. D. Meier. Read at recent convention of American Boiler Manufacturers' Assn. A comparison of present regulations here and abroad, with general consideration of the subject. 4000 w. Ir Age—Aug. 26, 1897. No. 14873.

Feed Water.

Normand's Feed Regulating Arrangement. Illustrated description of an arrangement patented by Augustin Normand & Co., of Havre, which has already been successfully tried. 600 w. Engng—Aug. 20, 1897. No. 14918 A.

Gages.

Concerning Mercury Columns. From *The Locomotive.* Method used in standardizing gages is explained. 2000 w. Mas St Fit—July, 1897. Serial. 1st part. 14431.

Corrosion and Breakage of Water Gage Glasses. G. D. Hiscox. Gives theories explaining the different cracking and breaking of glasses. 1300 w. Sci Am Sup—Aug. 7, 1897. No 14474.

Water-Tube Boilers.

See same title under Marine Engineering.

COMPRESSED AIR.

Compressor.

Corliss Air Compressor. (Corliss Luft Kompressor.) A powerful air compressor, with compound steam cylinder, and Corliss valves on the air cylinder, mechanically operated. The spring discharge valves are contained in the Corliss admission valves. 4500 w. 1 plate. Gluckauf—July 17, 1897. No. 14740 B.

Explosion.

Explosion of an Air Compressor at Dortmund. (Explosion eines Luft Kompressors bei Dortmund.) This fatal explosion was due to the gasification of the lubricant and ignition of the mixed gas and air by overheated portions of the machine. A curious and important case. 2500 w. Gluckauf—June 26, 1897. No. 14738 B.

Liquid Air.

Liquid Air and its Uses. G. D. Hiscox. An interesting account of its action on various substances, its appearance, advantages, &c. 2500 w. Compressed Air—Aug., 1897. No. 14672.

Motors.

Compressed Air Motors. Illustrated detailed description of the Hoadley-Knight motors, their construction and working. 3500 w. St Ry Jour—Aug., 1897. No. 14402 D.

ENGINES AND MOTORS.

Blowing Engine.

Horizontal Blowing Engine for Blast Furnace (Liègende Gebläsemaschine für Hochöfen.) Elevation, plan, and description of 700 H. P. double compound blowing engine. 1000 w. Zeitschr d Ver deutscher Ing—July 31, 1897. No. 14719 B.

Compound Engines.

Compound Engines and the Cost Account. R. H. Thurston. Discussion of what type of engine shall be used. 2300 w. Bos Jour of Com—Aug. 14, 1897. No. 14619.

Counterbalance Tests.

Counterbalance Tests of the Strong Engine at Purdue University. Report of recent tests, with conclusions, and editorial comment. 1500 w. R R Gaz—Aug. 6, 1897. No. 14477.

Cut-off.

Most Economical Cut-off. From advance sheets of Buckeye Engine Company's catalogue. Gives results of experiments of Professor Denton. 700 w. Am Mach—Aug. 5, 1897. No. 14468.

Engine Trials.

Superheated Steam Engine Trials. William Ripper. Read before the Inst. of Civil Engs. Describes experiments made to determine the steam consumption, dryness, nature of the heat exchange, and conclusions that may assist in the future development of superheating. Ill. 3000 w. Prac Eng—July 30, 1897. Serial. 1st part. No 14523 A.

Gas Engines.

Gas Engines. W. F. Kelly. Abridged from a paper read before the Engineers' Club of Columbus, O. Brief consideration of the different types and the more important features, with remarks on cost, economy, durability, &c. 2500 w. San Plumb—Aug. 15, 1897. No. 14660.

Gas Engines in French Flour Mills. Describes in detail an engine which received a Grand Prix at the International Exhibition at Rouen, in 1896, and has recently been erected to supply 530-horse power in a flour mill in Paris. Ill. 1200 w. Engng—Aug. 13, 1897. No. 14824 A.

Large Gas Engines. Gives advantages as compared with steam engines, showing that in England they are worked with economy. 1200 w. Bos Jour of Com—Aug. 7, 1897. No. 14499.

See Same title under Electrical Engineering, Lighting.

The Fairbanks-Morse Gas and Gasoline Engines. Presents some of the essential features of the engine made by this company. Ill. 1200 w. R R Gaz—Aug. 20, 1897. No. 14805.

The Sintz Gas and Gasoline Engines. The Sintz gasoline oil engine is illustrated and described. It is an American engine, operating with a two-stroke cycle. 1000 w. Eng News—Aug. 12, 1897. No. 14593.

Heat Motor.

Diesel's Rational Heat Motor. (Diesels Rationeller Wärmemotor.) A report of a test by Prof. Schröter, of Munich, of the new Diesel motor, showing the remarkable efficiency of 38.5 per cent. A valuable article on testing a motor. 8000 w. Zeitschr d Ver deutscher Ing—July 24, 1897. No. 14714 B.

High-Speed Engines.

High-Speed Self-Lubricating Steam Engines. Alfred Morcom. An important paper on quickly rotating engines and automatic lubrication read at meeting of the Inst. of Mech. Engs. at Birmingham, Eng. 5000 w. Eng, Lond—Aug. 6, 1897. No. 14606 A.

Leakage.

Leakage Tests of Valves and Pistons. From advance proofs of a book on "Engine Tests," by George H. Barrus. The importance of such tests and the methods of making them are discussed. 1600 w. Eng Rec—Aug. 21, 1897. No. 14830.

Link Motion.

The Locomotive Link Motion. F. A. Halsey. Part first discusses the applicability of the link motion to locomotive conditions and compares the stationary and shifting link motions, &c. 2200 w. Am Mach—Aug. 26, 1897. Serial. 1st part. No. 14886.

Marine Engines.

See same title under Marine Engineering.

Oil Engines.

Calculations for Oil Engines. W. H. Booth. Showing how the amount of cooling water may be found. 1400 w. Am Mach—Aug. 5, 1897. No. 14469.

Oil Engines. J. Warren. Presents some of the details of construction and working in connection with the leading oil engines at present in the market. 1500 w. Elec, Lond—July 30, 1897. No. 14502 A.

Pistons.

Piston Packing Rings of Modern Steam Engines. Otto C. Reymann. Investigates the methods of securing a steam-tight piston, and how packing rings are to be designed in order to exert the required pressure on the cylinder walls, devises formulæ for ring types generally used. 3500 w. Jour Fr Inst—Aug., 1897. Serial. 1st part. No. 14446 D.

Power Production.

The Economical Production of Power in Small Units. E. T. Adams. Showing the desirability of developing small engines with higher fuel-economy. 3200 w. Eng Mag—Sept., 1897. No. 14903 B.

Pumping.

Duplex Pumps. Their action, and why positively closed water valves permit of high speeds. 1500 w. Bos Jour of Com—Aug. 7, 1897. Serial. 1st part. No. 14498.

See same title under Marine Engineering.

Test of a High Speed Pumping Engine with a New System of Water Valves. Report of two tests recently made by H. W. Spangler and Edward T. Child. Shows that the capacity and speed of a pump may be increased 50% by simply changing the water valves. 2400 w. Eng News—Aug. 5, 1897. No. 14489.

Valves.

Engine Valve Motions. Theo. F. Scheffler, Jr. Comments on the general redesigning of valve motions which seems to be taking place, and describes a few of the most modern types of engines, particularly with reference to valve motion. 2800 w. Sci Mach—Aug. 1, 1897. No. 14436.

POWER AND TRANSMISSION.

Coal Shipment.

See same title under Mining and Metallurgy, Coal and Coke.

Hydrodynamics.

Establishment of a Uniform Flow in a Tube of Circular Section. (Etablissement du Régime Uniforme dans un Tuyan à Séction Circulaire.) A further discussion by M. Boussinesq, extending his analytical investigations to tubes of circular cross-section. 3000 w. Comptes Rendus—July 26, 1897. No. 14711 B.

Establishment of a Uniform Flow in a Pipe of Large Rectangular Section. (Etablissement du Régime Uniforme dans un Tuyan à Section Rectangulaire Large.) A discussion of this important problem by M. Boussinesq, with analytical formulas. 3000 w. Comptes Rendus—July 19, 1897. No. 14706 B.

Theory of Gradually Varying Flows of Different Rates. (Théorie Approchée du Passage d'un Régime Graduellement Varie à un Régime Rapidement Varié.) An elaborate mathematical treatment by M. Boussinesq. 3000 w. Comptes Rendus—July 12, 1897. No. 14704 B.

Pulleys.

The High Side of a Pulley. Points on the running of belts and the action of pulleys. Ill. 1300 w. Am Mach—Aug. 19, 1897. No. 14691.

Steam Power.

The Cost of Steam Power. Horatio A. Foster. Abstract of paper read before the Am. Inst. of Elec. Engs. Showing that any general statement of the cost of power per horse power per annum is incorrect, and that no such statement is of any value unless for plants employed in similar work under similar conditions. Gives tabulated data of plants tested. 4000 w. St Ry Jour—Aug., 1897. No. 14460 D.

Water Power.

The Limitations of Government in Water-Power Plants. Mark A. Replogle. Discusses the factors that determine the regulation of the speed. 1000 w. Am Mach—Aug. 19, 1897. No. 14692.

Windmills.

Influence of Load on the Power of a Windmill. E. C. Murphy. Shows by diagrams how the power of a windmill varies with the load on it. Ill. 1000 w. Eng News—Aug. 19, 1897. No. 14695.

SHOP AND FOUNDRY.

Armatures.

On the Construction of Armature Cores. William Baxter, Jr. Discusses past and present methods. Ill. 2300 w. Am Mach—Aug. 12, 1897. No. 14581.

Casting.

Casting a Difficult Metal. Methods used by the writer to get a perfect casting of copper, with the addition of from eight to twelve per cent. of aluminum. Ill. 700 w. Ir Trd Rev—Aug. 26, 1897. No. 14914.

Centering.

Centering. A. H. Cleaves. Methods are described and devices illustrated. 900 w. Am Mach—Aug. 19, 1897. No. 14689.

Cycles.

Some Points in Cycle Construction. F. J. Osmond. Read before the Inst. of Mech. Engs. Considers the causes of inefficiency to be want of rigidity and friction. Discusses also the factor of safety, large tubes, aluminum frames, testing of tubes, chain stays, gear and crank length, &c. 4000 w. Eng, Lond—July 30, 1897. No. 14518 A.

Dies.

Drawing Dies. J. L. Lucas. Illustrated description of the work. 1100 w. Am Mach—Aug. 12, 1897. No. 14576.

Fluid Iron.

The Pressure of Fluid Iron. R. D. Moore, in *Iron Molders' Journal*. The importance of rule for estimating the pressure of the metal on the mold. 1000 w. Ir Trd Rev—Aug. 19, 1897. No. 14688.

Fly-Wheels.

The Arms of Fly-Wheels Cast in One Piece—A Method of Constructing Additional Diagrams. Henry Hess. Diagrammatic solutions, with explanations. 1200 w. Am Mach—Aug. 12, 1897. No. 14579.

Gearing.

The Practical Delineation of Gear Teeth. (Sur le Tracé Pratique des Engrenages.) M. Le Cornu. The curves are assumed to be circular arcs, and the variation from uniform angular velocity is deduced. 1000 w. Comptes Rendus—July 19, 1897. No. 14707 B.

Joints.

Efficiency of Oblique Riveted Joints. Abstracted from *The Locomotive*. Explains what is meant by efficiency, and discusses how to find the effective efficiency. Ill. 1300 w. Am Mach—Aug. 12, 1897. No. 14578.

Lathes.

Small Error Limits in Large Lathes. John Randol. Discusses the error limit allowable, and cites the case of two 60-inch lathes of the same dimensions and details, recently ordered, one of which was accompanied by a minute detail of error limits and cost twice as much. Questions whether this excess of cost money was well spent. 2500 w. Am Mach—Aug. 26, 1897. No. 14884.

Machinery.

Manufacturing Methods as Applied to the Production of Machinery. F. A. Halsey. Introductory portion of a lecture before the engineering students of Cornell University. The methods described relate more to manufacture by the aid of special fixtures, rather than by special machines, and refer to pure machine-shop operations only. Am Mach—Aug. 19, 1897. No. 14693.

Pattern Making.

Selecting Pine for Pattern Making. John M. Richardson. Directions for detecting undesirable qualities. 800 w. Am Mach—Aug. 19, 1897. No. 14690.

Pipe Foundry.

The Chattanooga Pipe Foundry. Illustrated description of a new plant recently erected by the Chattanooga Foundry and Pipe Company. 1000 w. Am Mach—Aug. 12, 1897. No. 14577.

Tools.

Pump Center Dividers—Some Drilling Tools. A. H. Cleaves. Illustrated description of tools and methods of work. 900 w. Am Mach—Aug. 26, 1897. No. 14885.

Workshops.

The Management of Small Engineering Workshops. R. Y. R. The first of a series of articles which will consider the management of small shops, employing up to 150 or 200 hands, confining the attention to the internal working. 1700 w. Prac Eng—Aug. 13, 1897. Serial. 1st part. No. 14849 A.

Wrench Blanks.

Trimming Wrench Blanks. W. A. Warman. Illustrated description of arrangement used and found speedier and cheaper than milling. 600 w. Am Mach—Aug. 12, 1897. No. 14580.

MISCELLANY.

Automobiles.

Electrical Cabs. Describes the cabs put into service by the London Electrical Cab Company. 1700 w. Engng—Aug. 20, 1897. No. 14923 A.

Electric Motor-Cab Service in New York City. Illustrated description of the mechanically propelled vehicles, the station, motors, and steering and brake gear are given in part first. 2800 w. Elec Wld—Aug. 14, 1897. Serial. 1st part. No. 14628.

Heavy Motor Car Trials in France. An account of the recent trials of these vehicles made under direction of the Automobile Club de France. 4000 w. Eng, Lond—Aug. 20, 1897. No. 14933 A.

The Present Status of the Horseless Carriage Industry. W. Worby Beaumont. A descriptive article, comparing the various automobiles and their achievements, and showing that, while the motor vehicle is not yet perfect, it has reached the practical stage. Ill. 5000 w. Eng Mag—Sept., 1897. No. 14905 B.

Ball Bearings.

Experiments with New Forms of Ball Bearings. F. A. Farnsworth. Drawings, with description, of several new forms of ball bearings with which the author has experimented. 900 w. Ir Age—Aug. 5, 1897. No. 14439.

Balloon Expedition.

The Andree Balloon Expedition to the North Pole. Notes on this undertaking, which has been planned by engineers. Describes the arrangements and the departure. 2300 w. Eng News—Aug. 12, 1897. No. 14594.

Bicycles.

Points in Cycle Construction. F. J. Osmond. Synopsis of a paper read at recent meeting of the Inst. of Mech. Engs. at Birmingham, Eng. Importance of rigidity, factor of safety, design, &c., are considered. 1200 w. Ir Trd Rev—Aug. 19, 1897. No. 14687.

Tension of Spokes in Bicycle Wheels. D. W. Hering. A study of this subject, examination being made of the wheels of five high-grade machines. 2000 w. Eng News—Aug. 12, 1897. No. 14592.

The Bicycle as a Vehicle and in Military Service. (Das Fahrrad als Verkehrsmittel und im Heeresdienst.) Giving an account of the extent to which the bicycle has already been adopted in various armies, with suggestions for future use. 4500 w. Stahl und Eisen—July 15, 1897. No. 14751 D.

The Cycle Market. G. Lacy Hillier. Briefly reviews the history of the development of the bicycle and the causes of over production, predicting a severe crisis in the near future. 3000 w. Contemporary Rev—Aug., 1897. No. 14587 D.

Drills.

Thomas Drill with Regulating Ratchet. Jules Collin. Communication made to the Association des Ingénieurs sortis des l'Ecole de Liège. Gives particulars of this new apparatus, with illustrations. 1000 w. Col Guard—July 30, 1897. No. 14521 A.

Education.

The Electrotechnic Institute of the Stuttgart Technical High School. (Das Elektrotechnische Institut der Technischen Hochschule Stuttgart.) With floor plans, showing the arrangement of lecture halls, class rooms and laboratories. 5000 w. Zeitschr d Ver deutscher Ing—July 31, 1897. No. 14718 B.

The True Basis of Technical Education. W. Slingo. Read before the International Congress on Technical Education. The first aim should be to fit the student for a particular industry, and enable him to perform his work in a superior manner. Gives suggestions. 3500 w. Elect'n—Aug. 20, 1897. No. 14939 A.

Grindstones.

The Strains in Grindstones and Emery Wheels. (Der Spannungszustand in Schleifsteinen und Schmirgelscheiben.) A mathematical discussion of the conditions in rapidly revolving grinding wheels by Prof. Grübler of Charlottenburg, as a result of investigations into a recent disaster at Spandau. 4500 w. Zeitsch d Ver deutscher Ing—July 24, 1897. No. 14717 B.

Ladle.

Locomotive Ladle. (Locomotivgiess wagen.) A traveling ladle including crane, and propelling machinery, the whole traveling on a track. The ladle has a capacity of 25 tons. Photograph and elevation. 1000 w. Stahl und Eisen—July 15, 1897. No. 14749 D.

Linoleum.

Machinery for Manufacturing Linoleum. Part first describes the hand manufacture of floor cloth, the methods of manufacturing linoleum, the proportion of ingredients used, the general arrangement of a typical factory, and gives illustrated description of some of the machinery used. 3000 w. Engng—Aug. 6, 1897. Serial. 1st part. No. 14609 A.

Portable Recorder.

A Portable Recorder for Tests of Metals. Gustavus Charles Henning. Read before the Iron and Steel Inst., Cardiff. Illustrated description of instrument designed by the author, its application and general utility. 2000 w. Ind & Ir—Aug. 6, 1897. No. 14601 A.

Pumping.

The Pump. J. W. Hughes. Lecture delivered before the plumbing class of the Montreal Council of Arts and Manufactures. Part first explains the principle of operation, and the action of the lift pump. 2000 w. San Plumb—Aug. 15, 1897. Serial. 1st part. No. 14659.

Refrigeration.

The Mechanical Production of Cold. J. A. Ewing. Howard lecture before the Society of Arts. General consideration of the thermodynamical basis of the processes, and of the action of refrigerating machines. Ill. 8000 w. Jour Soc of Arts—Aug. 13, 1897. No. 14813 A.

Sewing Machines.

Our Sewing Machines. From the *N. Y. Sun*. Interesting information of this industry, its extent, export trade, and changes wrought by the invention. 2800 w. Sci Am Sup—Aug. 7, 1897. No. 14472.

Technology.

Progress in the Domain of Mechanical Technology. (Fortschritte un Gebiete der Mechanischen Technologie.) A review, by Prof. Kick, of some recent advances in various lines, as shown in the expositions at Nuremberg and Budapest. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—July 30, 1897. No. 14728 B.

Vans.

Steam Road Vans. The first of a series of articles describing some of the best types of steam vans for common roads. Ill. 1300 w. Mach, Lond—Aug. 15, 1897. Serial. 1st part. No. 14865 A.

Water-Raising.

Water-Raising Appliances. Philip R. Björling. Part first gives illustrated description of the earliest mechanical contrivances. 2000 w. Mech Wld—Aug. 6, 1897. Serial. 1st part. No. 14616 A.

MINING AND METALLURGY.

COAL AND COKE.

Coal Formation.

Coal the Result of Flotation and Deposition in Lakes. Dr. Philippe Glangeaud, in *La Nature*. Recent important modifications in ideas of the manner in which coal was produced. 800 w. Min & Sci Pr—Aug. 14, 1897. No. 14686.

Coal Shipment.

The Application of Travelling Belts to the Shipment of Coal. Thomas Wrightson. Read at meeting of Iron and Steel Inst., at Cardiff. Describes the way the author proposes to overcome the difficulties which have prevented the belt from being applied to the shipping of coal. Discussion follows. 4500 w. Col Guard—Aug. 6, 1897. No. 14607 A.

Coal Washer.

The Wunderlich Coal Washing Apparatus. (Stromwäsche; Patent Wunderlich.) Describing an improved apparatus for washing coal as used at the mines in Kladno, Bohemia. 1500 w. 1 Plate. Oesterr Zeitschr f Berg u Hüttenwesen—June 26, 1897. No. 14761 B.

Conveyer.

Coal Conveyer. An illustrated description of an improvement in coal conveying belting, patented by W. E. Kochs. 700 w. Eng, Lond—July 30, 1897. No 14514 A.

Explosions.

The Relation between Firedamp Explosives and Atmospheric Pressure. (Die Schlagwetter Explosionen mit Beziehung auf den Barometerstand.) The annual report for the Dortmund district for 1896, giving barograph curves and data of explosions, showing the relation between the relief of atmospheric pressure and the release of gas. 3000 w. 1 plate. Gluckauf—Aug. 7, 1897. No. 14743 B.

Production.

The Production of Coal in 1896. Report of he production in India, Spain, and the United States. 1600 w. Bd of Trd Jour—Aug., 1897. No. 14874 A.

Small Coal.

The Utilization of Small Coal. (Die Verwendung der Kleinkohle.) A discussion by Dr. Caspaar of the various methods of utilizing small coal, taking into account the commercial conditions as they exists in Germany. Two articles. 7500 w. Oesterr Zeitschr f Berg u Hüttenwesen—July 3, 17, 1897. No. 14762 E.

Spontaneous Combustion.

The Spontaneous Combustion of Coal. Discussion of paper by John L. Howard, read before the Pacific Coast Assn. 2200 w. Am Gas Lgt Jour—Aug. 16, 1897. No. 14635.

Spontaneous Ignition of Coal. John L. Howard. Read before meeting of the Pacific Coast Assn. Facts, theories, and statements bearing upon this subject, and gathered from various sources. 3300 w. Am Gas Lgt Jour—Aug. 9, 1897. No. 14531.

Submarine Workings.

Submarine Coal Workings in the North of Spain. Dach, in *Zeitschrift für das Berg-Hutten und Salinen-Wesen*. The method of working is described. 1100 w. Col Guard—July 30, 1897. No. 14520 A.

Tipplers.

Power-Driven Coal Tipplers. Illustrated description of an oscillating tippler which aims to avoid breakage and secure despatch. 1200 w. Col Guard—Aug. 20, 1897. No. 14928 A.

Victoria.

Systems of Coal Mining in Victoria. James Stirling. From the annual report of the Secretary for Mines, Victoria. The different systems used are described. 1100 w. Am Mfr & Ir Wld—Aug. 27, 1897. No. 14959.

GOLD AND SILVER.

Assaying.

Gold and Silver Assaying at Guanajuato, Mexico. W. N. Cummings. Description of a crucible used, which commends itself for the large number of fusions that can be made at once, the celerity and fuel economy. Ill. 500 w. Eng & Min Jour—Aug. 28, 1897. No. 14952.

Chlorination.

The Chlorination Process. Charles P. Williams. An outline description of the peculiarities of the various methods and appliances. The chemical process, the varieties of ores to which it is applicable, the method of treatment and how the process accomplishes the desired results. 4000 w. Col Eng—Aug., 1897. No. 14493 C.

Coolgardie.

The Gold Fields of Coolgardie. (Ueber die Gold Lagerstätten von Coolgardie.) An account of the new gold fields of Coolgardie, in West Australia, by correspondence from Herr Gmehling. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—July 31, 1897. No. 14765 B.

Cyanid.

Liquation in Cyanid Bars. Dr. Stockhauser. Abstract of paper read at meeting of Chemical and Metallurgical Society of South Africa. Discussing the fact that alloys of gold and silver with base metals do not solidify homogeneously, and that therefore errors may be made in assaying and sampling. Also discussion. 1500 w. Aust Min Stand—June 17, 1897. No. 14454 B.

Roasting Previous to Cyaniding. Wallace Macgregor. Presents the advantages of this method in certain cases, and gives suggestions. 1000 w. Eng & Min Jour—Aug. 14, 1897. No. 14643.

Successful Cyaniding. Illustrated description of the process as applied at the United Pyrites Works, Bendigo. 1600 w. Aust Min Stand—July 1, 1897. No. 14457 B.

Gold Belt.

Mines of the Gold Belt. W. H. Storms. Considers particularly the mines in the counties of Madera, Mariposa, Tuolumne, Calaveras, and Amador in California. 2000 w. Min & Sci Pr—July 31, 1897. No. 14490.

Gold Seekers.

The Gold Seeker in the West. Sam Davis. The life of the gold seeker, its privations and hardships, and the lessons taught. 3200 w. Chau—Sept., 1897. No. 14962 C.

Klondike.

British Yukon Mining Regions. An illustrated sketch of the district, its rich gold deposits, fuel supply, and other minerals ; the difficulties to be met, routes, &c. 2800 w. Can Eng—Aug., 1897. No. 14555.

In the Far Northwest. Extracts from report of William Ogilvie, surveyor to the Dominion government, on the extent of the gold bearing section, its richness, &c. 2000 w. W Min Wld—July 31, 1897. No. 14427.

Ontario and Alaska. Information in regard to the prospectus of the Sault Ste. Marie and Hudson's Bay Railway Co., which proposes not only to reach the Klondike, but to open up the the lands which lie in the basin of the Mackenzie river. Map. 1200 w. Can Eng—Aug., 1897. No. 14553.

The Alaska Gold Field. Russell L. Dunn. Discussion of this field with conclusions. The placers are believed to be derived from erosion of gold bearing lodes, the richness of the Klondike placer is likely to be equaled by other discoveries, and the conditions are different from other mining regions. Also editorial. 4500 w. Min & Sci Pr—Aug. 7, 1897. No. 14572.

The Geological Survey's Expedition to the Yukon in 1896. Harold B. Goodrich. An interesting account of the journey from Juneau to the interior. 2400 w. Harper's Wk—Aug. 14, 1897. No. 14565.

The Gold Fields of Klondike and the Yukon Valley. Harold B. Goodrich. Methods of mining pursued in Alaska, and the necessity of improvement in ways of getting to the gold district. Ill. 3600 w. Eng Mag—Sept., 1897. No. 14904 B.

The Klondike Mining-Camp. Accounts by George Hamlin Fitch and by C. A. Snowden, with illustrations. Gives particulars of the discovery of these rich mines, the processes of mining, &c. 4800 w. Harper's Wk—Aug. 7, 1897. No. 14426.

The Klondike Placers. Information of the mode of laying out the claims, manner of working, with account of early explorations as published in the *Canadian Engineer*. 1000 w. Eng. & Min Jour—Aug. 14, 1897. No. 14641.

The Yukon Goldfields. Extracts from Inspector Constantine's report to the government at Ottawa. On the richness of the deposits. 800 w. Aust Min Stand—July 1, 1897. No. 14458 B.

The Subsistence Question in the Klondike Region. Archibald A. Schenck. A letter arguing that under proper organization, and with proper effort, the winter may be the best time to make advancement into the Klondike region. The question of feed for the animals, where supplies must be transported is considered, and the construction of a wagon road recommended. 2400 w. R R Gaz—Aug. 20, 1897. No. 14802.

The Yukon Gold Region. Cyrus C. Adams. Valuable information gained by a Canadian surveyor, relating to important finds in the Klondike and other Yukon regions, routes, &c. Map & Ills. 1600 w. Harper's Wk—Aug. 14, 1897. No. 14564.

The Yukon Miner's Outfit. The outfit described is divided into clothing, subsistence, tools, and miscellaneous, and is prepared by one having a personal knowledge of the mining and climatic conditions. 1200 w. Min & Sci Pr—Aug. 7, 1897. No. 14573.

Transportation Routes to the Klondike. A summary of the reported routes existing and projected. 1200 w. Ry Age—Aug. 6, 1897. No. 14538.

Yukon Gold Region. Canada's Mining Regulations. Copy of the regulations governing placer mining on the Yukon, issued by the Canadian Government. 3300 w. Cons Repts—Oct., 1897. No. 14857 D.

Low-Grade Ore.

A Plant for Parting Low-Grade Bullion. F. Gutzkow. Illustrated description of the plant used by the writer. 1500 w. Eng & Min Jour—Aug. 21, 1897. No. 14811.

Mining Low-Grade Gold Ores in Alabama. William B. Phillips. Information of Clay County, discussing whether there is enough paying ore to warrant extensive gold-mining operations. Ill. 1500 w. Eng & Min Jour—Aug. 14, 1897. No. 14642.

Pelatan-Clerici Process.

The Pelatan-Clerici Process at the De Lamar Mill, Idaho. D.B. Huntley. A full description of the process aiming to correct wrong impressions, and to answer queries. Ill. 1600 w. Eng & Min Jour—Aug. 7, 1897. No. 14532.

Placer Mining.

Pointers on Placer Mining. Discusses the problems presented to the placer miner, and a few of the difficulties. 1400 w. Min Ind & Rev—July 29, 1897. No. 14432.

Prospecting.

Prospecting. Arthur Lakes. Extract from an instructive lecture recently delivered before the Miners' National Bureau, of Denver, Col., describing the formations most likely to be productive. 2300 w. Col Eng—Aug., 1897. No. 14495 C.

Scientific Prospecting. Thomas Smith. Part first calls attention to misleading teachings of geologists, and gives some directions based on facts found in the camp under investigation. 1500 w. Min & Sci Pr—Aug. 21, 1897. Serial. 1st part. No. 14916.

Slimes.

The Treatment of Slimes. Arthur J. Chappell. Describes method of treatment found successful; claiming the advantages of efficiency, cheapness and freedom of user. Consists in agitation and precipitation of the slimes, and the drawing off of the solution from the top. 600 w. Aust Min Stand—June 24, 1897. No. 14455 B.

Tasmania.

Scamander Mining District, Tasmania. J. Harcourt Smith. Report of the geological surveyor, pronouncing the prospects encouraging. 1300 w. Aust Min Stand—July 8, 1897. Serial. 1st part. No. 14509 B.

IRON AND STEEL.

Aluminum.

Aluminum in Steel. A. E. Hunt. From a paper entitled "The Utilization of Aluminum in the Arts," contributed to the *Aluminum World*. Reviews the special advantages to be gained by its use in steel manufacture. 2000 w. Ir Age—Aug. 5, 1897. No. 14438.

Analysis.

A Spectrographic Analysis of Iron Ores and Associated Minerals. W. N. Hartley and Hugh Ramage. Brief report of results in examination of the spectra of the flame from the converter used in the basic Bessemer process, and investigations of a large number of iron ores. 700 w. Ir & Coal Trds Rev—Aug. 13, 1897. No. 14820 A.

Armor.

See same title under Marine Engineering.

Carbon.

Recent Investigations in Refining, and in the Modifications of Carbon by Heating. (Neuere Arbeiten über Glühfrischen und die Veränderungen der Kohlenstoff-formen beim Glühen.) Discussing the formation of carbon in iron, either as free graphitic carbon or as carbid of iron. 6000 w. Stahl und Eisen—Aug. 1, 1897. No. 14754 D.

The Determination of Carbon as Hardening and as Carbid. (Bestimmung von Härtungs- und Carbidkohle.) A discussion by von Jüptner, of the various forms of combined carbon, and its influence on iron and steel. 7000 w. Stahl und Eisen—July 15, 1897. No. 14750 D.

Chrome Ore.

Chrome Ore. M. A. Clouet. Translated from the French. Where found, analyses from various localities, and the character of the surrounding strata are given in part first. 1000 w. Am Mfr & Ir Wld—Aug. 6, 1897. Serial. 1st part. No. 14542.

Cyfarthfa Works.

The Iron and Steel Institute. An account of two excursions, one in Old Dowlais, and the other to the Cyfarthfa Iron and Steel Works, with historical account of the latter which are especially interesting because of their antiquity. 4800 w. Eng, Lond—Aug. 20, 1897. No. 14932 A.

Export Iron.

Southern Export Iron. William B. Phillips. The importance of the question of composition in connection with iron to be exported, urging great care in grading. 1300 w. Ir Trd Rev—Aug. 26, 1897. No. 14913.

Galvanometers.

See same title under Electrical Engineering, Miscellany.

High Grade Steel.

High Grade Steel. J. C. Danziger. Briefly reviews the leading processes, and the means of varying the physical properties. 5000 w. Jour Assn of Engng Soc—July, 1897. No. 14623 C.

Hungary.

The Iron Industry of Hungary. David A. Louis. Read before the Iron and Steel Inst., Aug., 1897. A review of the production of recent years, with information of the leading companies, &c. Ill. 7000 w. Col Guard—Aug. 13, 1897. No. 14839 A.

Iron Melting.

Wrought Iron Melting in a Coke Hole. C. Vickers. A record of experiences. 1300 w. Ir Age—Aug. 19, 1897. No. 14682.

Iron Ores.

Development of Lake Superior Iron Ores. D. H. Bacon. Read before the Am. Inst. of Min. Engs., Tower, Minn. A short résumé of what has been done in this industry. 1300 w. Ir Trd Rev—Aug. 12, 1897. No. 14617.

Martin Process.

Notes on the Martin Process. (Verchiedenes über Martinofenvetrieb.) A discussion of Herr Springorum's report at the convention of the Eisenhüttenleute, upon the open hearth steel process, treating of details of performance during the past year. 5000 w. Stahl und Eisen—Aug. 1, 1897. No. 14753 D.

Metal Mines.

Characteristic American Metal Mines. Horace V. Winchell. Describing the Mines of the Minnesota Iron Company. Ill. 4000 w. Eng Mag—Sept., 1897. No. 14899 B.

Microsopy.

Microscopy and Practice. Extracts from an article published in *Stahl und Eisen*. Prof. Ledebur considers the probability of the microscope being employed as a regular adjunct to every steel and iron works. 1000 w. Ir Trd Rev—Aug. 26, 1897. No. 14912.

Molybdenum Steel.

Certain Properties of Molybdenum Steel. W. v. Lipin, in *Stahl und Eisen*. Compares molybdenum steel with wolframium steel and studies the treatment and effects. 600 w. Am Mfr & Ir Wld—Aug. 20, 1897. No. 14843.

Passive Iron.

Passive Iron. James S. de Benneville. Read before the Iron and Steel Inst., Cardiff. It is proposed to follow the history of this question as developed in the researches of successive investigators; to try and trace the connection as showing progress of the central idea; and to consider the condition of the reagent in which passivity was secured. Part first is largely historical. 2800 w. Ind & Ir—Aug. 6, 1897. Serial. 1st part. No. 14600 A.

Phosphorus.

The Determination of Phosphorus in Iron and Steel. (Die Phosphor Bestimmung in Stahl und Eisen.) A discussion by Herr Leopold Schneider, of the Molybdate method of determining phosphorus and of the requisite conditions for obtaining reliable results. Two articles. 6000 w. Oesterr Zeitschr f Berg-u-Hüttenwesen—June 12, 19, 1897. No. 14760 E.

The Influence of Phosphorus on Cold Short Iron. (Der Einfluss des Phosphors auf Kaltbruch.) A valuable paper by von Jüptner, giving analyses and tests, and discussing the various forms in which phosphorus appears in combination. 5000 w. Stahl und Eisen—July 1, 1897. No. 14746 D.

Rails.

High Carbon and Special Steels in Rails. G. Whitefield Chance. Discusses the high carbon and other special steels and the effects of various elements in steel, chemical composition, heat and mechanical treatment. 4000 w. R R Gaz—Aug. 27, 1897. No. 14888.

Refining.

Thermo-Chemical Study of the Refining of Iron. Honoré Ponthière. The object of the paper is to explain, as far as possible, from existing analytical and thermo-chemical data, the phenomena which occur during a blow in a converter. 1200 w. Ir & Coal Trds Rev—Aug. 13, 1897. No. 14821 A.

Rod Mill.

The Twin Rod Mill at the Joliet Works of the Illinois Steel Company. Illustrated description of the largest rod mill in the world. 2000 w. Ir Age—Aug. 19, 1897. No. 14681.

Russia.

See same title under Economics and Industry, Miscellany.

Sardinia.

Discoveries of Iron Ore in Sardinia. (Neue Eisenerzfunde auf der Insel Sardinia.) Giving a geographical and geological account of the recent valuable discoveries in Sardinia. The ores are mostly magnetite and red hematite. 3500 w. Stahl und Eisen—July 1, 1897. No. 14747 D.

Steel Construction.

See same title under Civil Engineering, Canals, Rivers and Harbors.

Sulphides.

On the Diffusion of Sulphides Through Steel. E. D. Campbell. Read before the Iron and Steel Inst. Describes investigations of diffusion of sulphide of iron through steel. Experiments and results. 1500 w. Ind & Ir—Aug. 6, 1897. Serial. 1st part. No. 14599 A.

Sulphur.

The Determination of Sulphur in Iron. (Bestimmung des Schwefels im Eisen.) A discussion of Campredon's method by Herr W. Schulte, with illustrations of apparatus. 5000 w. Stahl und Eisen—June 15, 1897. No. 14744 D.

Testing.

The Results of Rupture Tests. (Ueber Ergebnisse von Zerreissversuchen.) Giving diagrams and tables of comparative tests made upon the same material in different laboratories. Sheet iron tests were made at Charlottenburg, Munich, Zurich and Essen. 3000 w. Stahl und Eisen—August 1, 1897. No. 14752 D.

Tin-Plates.

The Manufacture of Tin-Plates. George B. Hammond. Read before the Iron and Steel Inst., at Cardiff. Reviews the progress of tin-plate manufacture, and deals specially with the manufacture, commencing with steel bars. Ill. 5000 w. Col Guard—Aug. 6, 1897. No. 14608 A.

Tube Works.

The Alma Tube Works. An account of the works at Walsall, Eng., giving an abstract of a specification for solid-drawn plain steel tubes, showing how severe are the requirements. The process is described. 3000 w. Engng—July 30, 1897. No. 14504 A.

MINING.

Accidents.

Fellow Aid in Mining Accidents. G. W. King. Illustrated instructions for miners, enabling them to render intelligent aid in an emergency. 2200 w. Eng & Min Jour—Aug. 28, 1897. No. 14951.

Bureau of Mines.

A Chief of Bureau of Mines for Pennsylvania. A certified copy of the law providing for the new officer, and defining his duties. 2300 w. Col Eng—Aug., 1897. No. 14494 C.

Drills.

See same title under Mechanical Engineering, Miscellany.

Electric Mining.

The Application of Electricity to Mining and Quarrying. J. Warren. Briefly describes the general details of a system suitable for use in mining operations. 2500 w. Elec, Lond—Aug. 6, 1897. No. 14589 A.

Explosives.

Further Researches on the Action of Explosives upon Fire Damp and Coal Dust. (Weitere Versuche Betreffend das Verhalten von Sprengstoffen Gegenüber Schlagwetter und Kohlensstaub.) With analyses of various explosives and tabulated results of experiments. Two articles. 8000 w. Gluckauf—July 3, 10, 1897. No. 14739 D.

High-Grade Blasting Gunpowder. A. F. Hargreaves. Read before the Mining Inst. of Scotland. Favorable to the use of gunpowder of a high standard and giving reasons why it should be placed on the list of permitted explosives. 1100 w. Col Guard—Aug. 20, 1897. No. 14930 A.

Magazines for Explosives in Coal Mines. Brief account of rules regulating the storage of explosives underground, especially in France. 1400 w. Eng & Min Jour—Aug. 28, 1897. No. 14950.

Report on the Explosives in Coal Mines Order, 1896. Two tables giving an abstract of the results of trials made. 700 w. Col Guard—Aug. 20, 1897. No. 14929 A.

The Danger of Ignition of Mine Gases by Explosives. (Ueber Gefahrlose Zündung von Sprengstoffen auf Schlagwetter Gruben.) Discussing the relative danger of various blasting powders in this respect, with especial consideration of the Westphalian coal mining district. 2500 w. Gluckauf—June 19, 1897. No. 14737 B.

Formulae.

Notes on Some Faulty Formulæ. H. W. Halbaum. The paper draws the attention of mining men to some few formulæ in current use which are either unnecessarily clumsy or misleading in many circumstances to which they are constantly applied. 5500 w. Col Guard—Aug. 13, 1897. No. 14837 A.

Mine Accounts.

Mine Accounts. J. Parke Channing. Analyzing the expenses of mine operation, and suggesting a method of recording them. 3700 w. Eng Mag—Sept. 1897. No. 14902 B.

Mine Regulations.

Additional Mine Regulations in the Breslau District. Changes, chiefly relating to ventilation and use of explosives. 1600 w. Col Guard—Aug. 13, 1897. No. 14838 A.

Mine Stock.

Mine Stock: Its Use and Abuse. Charles E. Bowron. Directions for proper stabling of the animals, whether beneath or above surface, their food, care and work. 1700 w. Tradesman—Aug. 1, 1897. No. 14433.

Ohio.

Ohio Mining in 1896. Information from the twenty-second annual report which has just been filed. 1200 w. Eng & Min Jour—Aug. 21, 1897. No. 14810.

Smokeless Powders.

Some New Features in Smokeless Powders and Their Ballistic Results. Hudson Maxim. Presents the advantages of the Maxim-Schüpphaus smokeless powder, with tables showing the results of firing with it. Ill. 5700 w. Eng, Lond—July 30, 1897. No. 14512 A.

Surveying.

Surveying Mining Claims. Charles Tappan. Describes the transit work and chaining, showing the accuracy of modern methods. 2000 w. Jour Assn of Engng Soc—July, 1897. No. 14724 C.

Underground Fire.

Underground Fire Attributed to Electric Conductors. From a communication to the *Annales des Mines* by M. L. Champy, after a report by Bergrat J. Mayer. The special cause to which experts attributed the fire in the Hermenegilde pit of the Kaiser Ferdinand Nordbaku Collieries, the difficulties of the rescue, recommendations of precautionary measures, &c. 2000 w. Col Guard—Aug. 13, 1897. No. 14836 A.

MISCELLANY.

Aluminum.

The Utilization of Aluminum in the Arts. Alfred E. Hunt. Discusses the Use of Aluminum in the manufacture of steel ingots and castings, in cast iron, nickel aluminum, cooking utensils, in chemical laboratories, in surgical instruments and appliances, bicycle parts, lithographic work, &c. 12000 w. Jour Fr Inst—Aug., 1897. Serial. 1st part. No. 14445 D.

Determining Minerals.

A Critical Review of the Methods of Determining Minerals. Dr. Joseph W. Richards. Examines the two systems of mineral classification, and reviews the methods of identification, giving the directions as taught at the Lehigh University. 4000 w. Jour Fr Inst—Aug., 1897. No. 14448 D.

Kaolin.

Kaolin in Vermont. J. Nelson Nevius. Deposits found at South Wallingford, Vt. Ill. 800 w. Eng & Min Jour—Aug. 14, 1897. No. 14644.

Manganese.

Some of the Manganese Deposits of the Valley of Virginia. Charles Catlett. Describes the ores and the various deposits. 1800 w. Eng & Min Jour—Aug. 7, 1897. No. 14533.

Monazite.

Monazite from Idaho. Waldemar Lindgren. Report of the widespread occurrence of this mineral in the Idaho basin. 1100 w. Min & Sci Pr—Aug. 21, 1897. No. 14915.

Monazite. H. B. C. Nitze. This paper embodies the results, in somewhat condensed and rearranged form, of previous communications which have appeared in the Sixteenth Annual Report of the U. S. Geol. Survey, and in Bul. No. 3 of the North Carolina Geol. Survey. Describes the mineral, where found, on what its value depends and price. 2400 w. Jour Fr Inst--Aug., 1897. No. 14447 D.

Quarrying.

A New Method of Quarrying Without Explosives. (Enie Neue Vorrichtung zum Auffahren von Gesteinsstrecken ohne Schiessarbeit.) A combinatlon of wedges and battering ram, the wedges being inserted in drill holes and spread by a ram until the rock is split. 2500 w. Gluckauf--July 31, 1897. No. 14742 B.

Tin.

The Malay Tin Industry. T. Flower-Ellis. Read at meeting of Chemical and Metallurgical Society of South Africa. Part first deals with the deposits, methods of mining, and methods of extraction. 2100 w. Aust Min Stand--July 24, 1897. Serial. 1st part. No. 14456 B.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Address.

Address of the President (T. R. Parker, of Napa, Cal.), Fifth Annual Meeting of the Pacific Coast Gas Association. A general talk on matters of interest. 3500 w. Am Gas Lgt Jour--Aug. 9, 1897. No. 14530.

Inaugural Address of A. Bell before the North British Association of Gas Managers. Treats of the education of the gas engineer, need for commercial methods in the industry, the relative merits of sulphate of ammonia and nitrate of soda, &c. 3500 w. Gas Wld—July 31, 1897. No. 14527 A.

South Metropolitan Gas Company. Brief account of the meeting giving an interesting address by the chairman, Mr. George Livesey, with short discussion and editorial. 5000 w. Jour Gas Lgt—Aug 17, 1897. No. 14872 A.

Accounts.

The Uniformity of Gas Accounts. C. O. G. Miller. Read before the Pacific Coast Gas Assn. The manner of keeping a record of the business is discussed. 3800 w. Am Gas Lgt Jour—Aug. 23, 1897. No. 14814.

Acetylene.

A Description of Acetylene Gas Plant. C. B. Outon. Describes an apparatus of the writer's construction which has recently been erected at one of the Great Southern and Western Railway stations and used with success. Read before the North of Ireland Assn. of Gas Managers. 700 w. Gas Wld—Aug. 14, 1897. No. 14848 A.

Illumination of College Buildings by Acetylene. Orrin E. Dunlap. Brief account of the adoption of this system of lighting by the Niagara University and Seminary of Our Lady of Angels. Ill. 450 w. W Elec—Aug. 21, 1897. No. 14835.

Consumption.

Ways and Means of Increasing Gas Consumption. H. Pooley. Read before the meeting of the North British Assn. Treats the subject with reference to the relation between manufacture and consumption, and with regard to the creation of an additional demand. 3000 w. Gas Wld—July 31, 1897. No. 14528 A.

Fuel Gas.

A Comparison of Fuel-Gas Processes. F. L. Slocum. Extracts from a paper read before the New York section of the Society of Chemical Industry. Discusses coal gas production by distillation, including bye products, ovens, bituminous coal, water-gas producers, and producers of the Mond and Siemens type. 3300 w. Jour Gas Lgt—Aug. 17, 1897. No. 14871 A.

Gas Uses.

The Extending Use of Gas in Industrial Operations. Frederick H. Shelton. Describing the different kinds of commercial gas and their applications in manufacturing. 4200 w. Eng Mag—Sept., 1897. No. 14906 B.

Gas Works.

The Amsterdam Gas Works. Henry H. Salmons. Read before the Incorporated Institution of Gas Engineers. Descriptive. 4000 w. Am Gas Lgt Jour—Aug. 9, 1897. No. 14529.

Manufacturing.

Reminiscences of Gas Manufacturing and Kindred Matters. F. H. Eichbaum. Personal experiences, with brief discussion. Read at annual meeting of Pacific Coast Assn. 3400 w. Am Gas Lgt Jour—Aug. 16, 1897. No. 14636.

Municipal Control.

Municipal Control. C. W. Quilty. Read before the Pacific Coast Gas Assn. A legal, commercial, and political review of the question of municipal ownership. 3500 w. Am Gas Lgt Jour—Aug. 23, 1897. No. 14815.

Natural Gas.

Changing a Coal Gas System to the Use of Natural Gas. John Kempf, Jr. Read before the Pacific Coast Assn. An account of work at Salt Lake City, with discussion. 2400 w. Am Gas Lgt Jour—Aug. 16, 1897. No. 14639.

Oxygen.

The Estimation of Oxygen in Coal Gas. Presents the need of a rapid method of more accurately determining oxygen, and describes the method of Dr. Otto Pfeiffer, of Magdeburg. 2000 w. Jour of Gas Lgt—Aug. 17, 1897. No. 14869 A.

Purifying.

The Best and Most Economical Means of Purifying Gas. D. M. Nelson. Abstract of paper read before the North British Assn. of Gas Managers. Claiming that lime used in conjunction with oxid of iron was the best and most economical means of purifying gas. Short discussion. 3000 w. Gas Wld—Aug. 7, 1897. No. 14603 A.

Recuperator Benches.

Recuperator Benches for Coke and Coal Firing. Daniel R. Russell. Read before the Pacific Coast Assn. Explains the conditions requisite for the installation of semi-recuperator benches, and their operation, giving a table of comparative results. Discussion. 3800 w. Am Gas Lgt Jour—Aug. 23, 1897. No. 14817.

Retorts.

A Short History of a Long Life. C. M. Converse. Discusses the length of life of a bench of clay retorts. Read before the Pacific Coast Assn. 2200 w. Am Gas Lgt Jour—Aug. 23, 1897. No. 14816.

Small Towns.

The Management of Lighting Plants in Small Towns. Thomas D. Petch. Read before the Pacific Coast Assn. Hints on the management, leakages, meter testing, purification, &c., with discussion. 3500 w. Am Gas Lgt Jour—Aug. 16, 1897. No. 14640.

Water Gas.

Lecture on Carburetted Water Gas. Ivison Macadam. Delivered at the annual meeting of the North of Ireland Assn. of Gas Managers. Explains the reactions necessary in the production, describes plant and its working and discusses a few of the advantages. 2800 w. Gas Wld—Aug. 21, 1897. No. 14937 A.

The Dellwik Water Gas Process. The substance of an interesting pamphlet by Dr. E. Fleischer, with special reference to the relation between the yield of gas and the extent to which the proportion of carbonic acid is pushed up in the blast gases. 3500 w. Gas Wld—Aug. 7, 1897. No. 14602 A.

Water-Gas as an Illuminant. Hugo Strache. Discussion of water-gas for lighting purposes, the recent improvements, safety burners, and other appliances. 3000 w. Pro Age—Aug. 16, 1897. No. 14651.

Welsbach.

Incandescent Gas and Electric Lighting: A Comparison. W. W. Gillespie. Claims superiority of the Welsbach incandescent gas light over other methods and suggests means of extending its use. Also discussion. 3000 w. Am Gas Lgt Jour—Aug. 16, 1897. No. 14638.

The Welsbach Light. G. I. Kinney. Read before the Pacific Coast Assn. Details in regard to the installation of this light, that the writer has found important for its successful use. 1500 w. Am Gas Lgt Jour—Aug. 16, 1897. No. 14637.

SEWERAGE.

Drainage.

The Composition of Drainage Water. (Sur la Composition des Eaux de Drainage.) Showing the proportion of nitrogenous constituents and giving a discussion of the fertilizing value. 2500 w. Comptes Rendus—July 26, 1897. No. 14712 B.

Sewage.

Sewage Filter Beds at Paris, Tex. Information regarding the first sewage purification plant in the south. Ill. 1100 w. Eng News—Aug. 12, 1897. No. 14590.

The Liernur Exhaust System. (Le Système Aspirateur Liernur.) Describing the details of the installation of the Liernur pneumatic system of sewage removal at Trouville-sur-mer. 2500 w. La Revue Technique—July 25, 1897. No. 14702 D.

STREETS AND PAVEMENTS.

Asphalt.

Tests of Artificial Asphalt. (Prüfung von Künstlishem Asphalt.) Data of tests made at the Royal testing Laboratory at Berlin, with an account of methods, and tables of results. 4500 w. Mitt aus d Kg tech Versuchsaustalten—Part I. 1897. No. 14759 E.

Brick.

Vitrified Brick—Their Manufacture and Advantages as a Paving Material. J. W. Sibley. Read before the annual meeting of the Alabama Industrial and Scientific Society. Considers only the vitrified brick made of shale. 1300 w. Brick—Aug., 1897. No. 14435.

Water Meter.

The "Venturi" Meter in Relation to the Measurement of Water in Large Mains. W. G. Kent. Read before the British Assn. of Water-works Engineers. A description of the instrument and its action. 2500 w. Jour Gas Lgt—Aug. 17, 1897. No. 14870 A.

Water Works.

Hereford City Waterworks. Illustrated description of the two engines substituted for two single-cylinder condensing beam engines which previously did the work, and the economy resulting. 1500 w. Eng, Lond—July 30, 1897. No. 14517 A.

The City of Birmingham Corporation Water-Works. Henry Davey. Read before the Inst. of Mech. Engs. Information of the supply, reservoirs, steam pumps, cost of pumping, &c., with other matters of interest. 2700 w. Eng, Lond—July 30, 1897. No. 14519 A.

The Torquay Water-Works. W. Ingham. Read before the British Assn. of Water-Works Engs. An abstract of paper and discussion. Deals with the watersheds, mains, storage cisterns, &c. 3300 w. Jour Gas Lgt—Aug. 10, 1897. No. 14684 A.

Water-Works of Camden, N. J. Describes the artesian well system. 1500 w. Fire & Water—Aug 21, 1897. No. 14809.

MISCELLANY.

Garbage.

Garbage Collection and Disposal at Halifax, Nova Scotia. Instructions to householders, and specifications under which the contract for removal was awarded. 2200 w. Eng News—Aug. 19, 1897. No. 14696.

See same title under Electrical Engineering, Lighting.

The Utilization of New York Garbage. An illustrated description of the plant on Barren Island for the disposal of garbage. 1600 w. Sci Am—Aug. 14, 1897. No. 14567.

Sanitation.

The Sanitation of Small Towns. (Abfuhr der Abfallstoffe, &c., in Mittler und Kleineren Städten.) A discussion of this important subject by Baumeister Schmick, of Frankfurt a. M. 6000 w. Gesundheits Ingenieur—July 31, 1897. No. 14784 B.

Tenements.

See same title under Architecture and Building, Miscellany.

Wastes.

Disposal of the Wastes of New York City. Illustrated account of the arrangements for the disposal of paper and refuse. 1600 w. Sci Am—Aug. 28, 1897. No. 14863.

Wood Pavement.

Street Wood-Pavement in Paris. Report of the high favor in this city, discussing the kind suitable for street paving ; the qualities desirable, accounts of tests made, and much other information. Ill. 13000 w. Ap. Series of Ind Forester—Part I. No. 14679 D.

WATER SUPPLY.

Construction.

Faulty Construction in Water Works Plants.—Its Effects upon Fire Departments and Cost of Insurance. William L. Cameron. Read at covnention of American Water Works Assn., at Denver, Colo. Briefly reviews some of the causes of poor construction. 1100 w. Fire & Water—Aug. 7, 1897. No. 14549.

Corrosion.

The Removal of Internal Corrosion from the Mains of the Kendal Water-Works. T. N. Ritson. Read before the British Assn. of Water-Works Engineers. An abstract of the paper and discussion. Describes the writer's experiences in the scraping of the mains. 3300 w. Jour Gas Lgt—Aug. 3, 1897. No. 14570.

Filtration.

Experiments in Water Filtration at St. Louis. Information in response to request, with copy of report of John F. Wixford, chemist of the water department. 2300 w. Munic Engng—Aug., 1897. No. 14449 C.

Hydrodynamics.

See same title under Mechanical Engineering, Power and Transmission.

Pumping.

Pumping Machinery. Alfred Fowler. Abstract of paper read before the British Assn. of Water-Works Engs. Describes a plant that has replaced an old Cornish engine at the Everton pumping station of the Liverpool Corporation. 1600 w. Jour Gas Lgt—Aug. 10, 1897. No. 14685 A.

Recorders.

Electrical Water-Level Recorders, and Their Use in Connection with Water-Works. W. Coles Finch. Abstract of a paper read before the British Assn. of Water-Works Engs. Illustrated description of the instrument, with the conclusions that beside the purpose for which it was intended it can be used for detecting and locating waste, for indicating the variations of level in wells, and for testing the yield. 1600 w. Elec Eng, Lond—Aug. 6, 1897. No. 14598 A.

Signalling Gear.

See same title under Marine Engineering.

RAILROAD AFFAIRS.

NEW CONSTRUCTION.

Construction.

Current Railway Construction. Reviews the most important works now pending in connection with British railways. 2000 w. Engng—Aug. 20, 1897. No. 14922 A.

The Strong Compound Balanced Locomotive.

Illustrated description with dimensions. 1700 w. Eng News—Aug. 19, 1897. No. 14698.

Mail Catcher.

Railway Mail Catcher and Delivery Devices. An illustrated description of the Fleming mail catcher, one of three devices tested and approved by the Post Office Department at Washington, D. C. 1000 w. Sci Am—Aug. 14, 1897. No. 14566.

Private Cars.

Private Cars. Duane Doty. Illustrated description of the car "Ellsmere," with remarks defending the practice of using private cars. 1800 w. R R Car Jour—Aug., 1897. No. 14544.

Wheels.

Wheel Mounting and its Relation to the Wheel Gage. Edward Grafstrom. Calls attention to a defect in Rule 3, of the new M. C. B. code. Ill. 1200 w. Aug. 27, 1897. No. 14889.

MAINTENANCE OF WAY.

Drawbridge.

Drawbridge Over Tallahatchie River—Yazoo & Mississippi Valley R. R. Illustrated description of a pivot drawbridge. 1600 w. Ry Rev —Aug. 28, 1897. No. 14957.

Niagara Bridge.

See same title under Civil Engineering, Bridges.

Rails.

See same title under Mining and Metallurgy, Iron and Steel.

Roadbeds.

Dustless Roadbeds. Theory and practice in the use of oil coated ballast as a dust preventive on the Pennsylvania road. Apparatus used is illustrated. 1300 w. Ry Age—Aug. 6, 1897. No. 14539.

Standards.

Value of Standards for the Maintenance of Way and Structures. W. G. Curtis. Arguing for the use of standard methods, and giving illustrations of some of the recent standards of the Southern Pacific Co. 1200 w. Ry Mag—July, 1897. No. 14657 C.

Station.

New Passenger and Freight Station at Montgomery, Ala.; L. & N. R. R. Illustrated description of arrangement and design. 1400 w. Eng News—Aug. 19, 1897. No. 14694.

Union Passenger Station at Springfield, Illinois. Illustrated description of a commodious and beautiful station to be built within the present year. 1000 w. Ry Rev—Aug. 14, 1897. No. 14663.

Tracks.

Chicago Track Elevation. Plan and profile of the work to be done this year by the Chicago & Northwestern Railway and the Pittsburg, Cincinnati, Chicago & St. Louis Railway jointly in elevating the tracks running south in Rockwell Street from the Galena Division. 700 w. R R Gaz—Aug. 13, 1897. No. 14584.

Track Elevation in Rockwell Street, Chicago. Description, with map of tracks, of the most expensive piece of track elevation for the distance, yet undertaken in Chicago. 2000 w. Ry Rev —Aug. 21, 1897. No. 14851.

Victoria Bridge.

See same title under Civil Engineering, Bridges.

TERMINALS AND YARDS.

Switches.

Electro-Pneumatic Push-Button Machine in the Pennsylvania Yards at Altoona, Pa. Illustrated description of plant in the distribution yard of the Pennsylvania Railroad at Altoona. The device is intended for work where interlocking is not required, but where a large number of movements must be performed in rapid succession. 1000 w. Ry Rev—Aug. 28, 1897. No. 14958.

TRANSPORTATION.

Accidents.

Train Accidents in the United States in June. Detailed list with classified summary. 3200 w. R R Gaz—Aug. 13, 1897. No. 14585.

Earnings.

Continued Improved Railway Earnings. Report of prosperous business on all roads except soft-coal carriers, with comparative tables showing increases and decreases of 118 railroads. 2500 w. Bradstreet's—Aug. 14, 1897. No. 14613

Net Railway Earnings. Report for second quarter of the present year showing slow, but gradual improvement. Also tables of comparison. 2500 w. Bradstreet's—Aug. 21, 1897. No. 14807.

English Railways.

The Home Railway Half-year. Report of results of the half-year's workings of the principal English railways, showing general prosperity. 3000 w. Trans—Aug. 13, 1897. No. 14842 A.

Fast Trains.

A Very Fast Regular Train. Report of the excellent time made between Philadelphia and Atlantic City, on the Philadelphia and Reading. 500 w. R R Gaz—Aug. 13, 1897. No. 14586.

Gradients.

The Influence of Gradients on Speeds and Loads. Instructive statement of results in the running of two test trains on the Midland, on the Eastern, and on the Orange Free State Northern, with the object of ascertaining the actual and relative cost of haulage, as well as the cost of return empties. Tabulated statements are given. 1500 w. Engng—Aug. 13, 1897. No. 14826 A.

Train Services.

The Summer Train Services. Charles Rous-Marten. Comment on the marked retrogression, so far as speed goes, on the English railways. No such records as were made a year ago are shown though the time is better than before the "race." Also calls attention to novelties on the different roads. 2000 w. Eng, Lond—July 30, 1897. No. 14513 A.

MISCELLANY.

Air-Brake Instruction.

A Model Air-Brake Instruction Room. Brief illustrated description of the new and complete instruction equipment of the St. Paul and Duluth Road. 1200 w. Ry Age—Aug. 20, 1897. No. 14819.

China.

The Actual Railway Situation and the Alleged Opportunities for American Engineers in China. Andrei Kimta. A full explanation of the situation. Conditions not promising for Americans. 2400 w. Eng News—Aug. 5, 1897. No. 14488.

Counterbalancing.

Locomotive Counterbalancing and its Effects. A. H. Angier. Translated from the French as published in the *Revue Generale des Chemins de Fer.* A study of the problem for the sake of substituting rational methods for the arbitrary system in actual use as stated by the author. 3000 w. R R Gaz—Aug. 20, 1897. Serial. 1st part. No. 14804.

Curves.

The Construction of Transition Curves for Railways. (Zur Construction der Uebergangsbögen bei Eisenbahngeleisen.) A mathematical discussion by Herr Alfred Birk, of the advantages of the lemniscate of Bernoulli as a figure for railway curves. Tables are given, simplifying the application of the curve to practice. 10,000 w. Oesterr Monatschr f d Oeffent Baudienst—August, 1897. No. 14734 D.

Equatorial Africa.

The Railways of Equatorial Africa. Names the most important systems constructed, in course of construction, or projected in the African continent, and gives interesting information relating to them. 3000 w. Bd of Trd Jour—Aug., 1897. No. 14875 A.

India.

The Railways and Trade in India. Discusses the decrease caused by the famine and plague. The report of passenger traffic is generally favorable. 1600 w. Engng—Aug. 20, 1897. No. 14921 A.

Light Railways.

Light Railways in Belgium. A report of the remarkable progress of these lines. 2000 w. Eng, Lond—Aug. 6, 1897. No. 14605 A.

Railroad Statistics.

The World's Railroads. Editorial consideration of some of the details given in the *Archiv für Eisenbahnwesen*, published by the Prussian Ministry of Public Works. 1100 w. R R Gaz—Aug. 6, 1897. No. 14478.

Railroad Supplies.

See same title under Econcmics and Industry, Commerce and Trade.

Railway Operation.

Good Discipline as a Factor of Safety in Train Operation in England. Editorial on information given in the English Board of Trade report, showing that most accidents are the result of carelessness, and that the system of investigation and of discipline exert a powerful influence toward the prevention of accidents. 2800 w. Eng News—Aug. 12, 1897. No. 14595.

Russia.

The Railways of Russia. John H. Converse. Observations of an American, just returned from an extended European tour. 1000 w. Ry Age—Aug. 13, 1897. No. 14650.

Shops.

Chicago, Indianapolis, and Louisville Shops at La Fayette, Ind. Brief description, with engravings of some locomotive details used by this road which differ from general practice. 1200 w. R R Gaz—Aug. 6, 1897. No. 14475.

Soudan.

The Soudan Railroad. C. H. Grinling. An account of the railroad operations that will assist in following future developments. Historical review. 3500 w. R R Gaz—Aug. 13, 1897. No. 14583.

Washout.

The Railway Disaster at Kolomea. (Die Eisenbahm Katastrophe bei Kolomea.) A fully illustrated account of the disaster at Kolomea, Austria, in which a washout caused a bridge fall and train wreck; with photographs, and detail drawings. 2500 w. Oesterr Monatschr f d Oeffent Baudienst—August, 1897. No. 14736 D.

Westinghouse Plant.

The Westinghouse Air Brake Company's Plant. A general account of the plant and of the processes employed in the manufacture of air brake equipment. 2300 w. Ry Age—Aug. 6, 1897. No. 14540.

Siberian Railway.

Structures on the Trans-Siberian Railway. Illustrated description of structures showing the substantial character of the work performed by the Russian government. 1100 w. Eng News—Aug. 12, 1897. No. 14591.

MAINTENANCE OF EQUIPMENT.

Baggage Cars.

Sanding the Ends of Baggage Cars. A. J. Bishop. A letter reporting satisfactory results on the Northern Pacific Railway, and the method used in sanding. 900 w. R R Car Jour—Aug., 1897. No. 14547.

Brakes.

Inside Hung Passenger Car Brakes. Report of discussion of this subject at the June convention of the Master Car Builders' Assn. 1800 w. R R Car Jour—Aug., 1897. No. 14545.

Instruction Car.

Air-Brake Instruction Car on the "Big Four Route." Illustrated description of the interior of this car. 1500 w. Sci Am—Aug. 21, 1897. No. 14669.

Air Brake Instruction Car; B. & M. R. R. Illustrated description of a car recently built by the Boston & Maine R. R. designed to give all information possible in the mechanism of the brakes. 900 w. R R Car Jour—Aug., 1897. No. 14546.

Locomotives.

American Locomotives for China and Japan. Illustrated description of some new Brooks engines for the orient. 1600 w. Ry Age—Aug. 6, 1897. No. 14541.

Eight-Wheel Passenger Locomotive—St. Lawrence & Adirondack Railroad. Illustrated description with general dimensions. 700 w. R R Gaz—Aug. 27, 1897. No. 14887.

Locomotives for the Waterford, Limerick and Western Railway. Illustrated description of four types of new engines, and tenders, and tank engines designed for work on a line with sharp curves and severe gradients. Dimensions are given. 900 w. Eng, Lond—Aug. 13, 1897. No. 14832 A.

Oil Burning Locomotives. Kirtland H. Wade. A consideration of the subject of liquid fuel, the vastness of the petroleum product, &c. with supplementary remarks by C. F. Lape. Ill. 3500 w. Ry Mag—July, 1897. No. 14658 C.

Speed of Rotation for Locomotive Engines. William F. M. Goss. On the importance of locomotives being designed with due regard to the performance of the engine under different speeds of rotation. 1400 w. Ry Mag—July, 1897. No. 14656 C.

Test of the Strong Balanced Locomotive at Purdue University. Abstract of the report of W. F. M. Goss, with discussion of the practice and principles. 3800 w. Sci Am Sup—Aug. 21, 1897. No. 14671.

The Purdue Tests of Strong's Balanced Locomotive. George S. Strong. A letter to the editor giving reasons for holding opinions differing from those expressed in a recent editorial in this paper. 1500 w. R R Gaz—Aug. 13, 1897. No. 14582.

STREET AND ELECTRIC RAILWAYS.

Accumulators.

See same title under Electrical Engineering, Power.

Brakeshoes.

A New Composition Brakeshoe. Describes the "Allen-Morrison Elastic" brakeshoe which has successfully withstood three months service tests on the South Elevated Railroad of Chicago. Also editorial. 1900 w. R R Gaz—Aug. 27, 1897. No. 14890.

Cables.

Novel Method of Cable Carrying. An illustrated account, from the *Journal* of Telluride, Colo., of twelve-thousand feet of tramway cable packed on mules. 350 w. Min & Sci Pr—Aug. 7, 1897. No. 14571.

Competition.

Suburban Competition. Charles J. Bates. Brief comparison of the economy of the central station with the locomotive as applied to suburban service. 1000 w. R R Gaz—Aug. 6, 1897. No. 14476.

Contact.

Single Acting Rail Contact. (Einseitig Wirkende Schienencontact.) An illustrated account of an improved electric contact attached to the rail and operated by wheel pressure, for the operation of bells, signals, &c. 1500 w. Zeitschr d Oesterr Ing u Arch Ver—July 23, 1897. No. 14726 B.

Controllers.

Economy in Controller Handling. J. R. Cravathe. Discusses whether a rapid or slow advancement of the controller handle in starting a car is the more economical in practice. Favors slow acceleration. 900 w. St Ry Rev—Aug. 15, 1897. No. 14654 C.

Electric Car.

The Pyott Electric Street Car. Illustrated description of a novel departure in street car building, embodying a number of features effecting the ease and comfort of passengers. 700 w. Elec Eng—Aug. 12, 1897. No. 14562.

Electric Plants.

See same title under Electrical Engineering, Power.

Electric Traction.

Mechanical Features of Electric Traction. Philip Dawson. Read before the Inst. of Mech. Engs. Part first presents the importance of the subject and considers the outside work and rolling stock. 6500 w. Elec Eng, Lond—Aug. 6, 1897. Serial. 1st part. No. 14597 A.

Elevated Railways.

An Inquiry into Elevated Railway Equipment and Service. Editorial on the recent papers by S. H. Short and M. H. Gerry, Jr. 2300 w. Ry Rev—Aug. 14, 1897. No. 14664.

Expenses.

Standard Distribution of Street Railway Receipts and Expenses. Discusses the system adopted in the state of New York and recommends its adoption, with slight changes, as a standard to be used generally. 1200 w. St Ry Jour—Aug., 1897. No. 14461 D.

Fairmount Park.

The Electric Transportation System of Fairmount Park, Philadelphia. Illustrated detailed description of the methods by which this line has been constructed without interfering with the beauty or enjoyment of the park. 3000 w. St Ry Jour—Aug., 1897. No. 14459 D.

Feeders.

Feeder Lines. Gives facts regarding street railways operating under different conditions. 2200 w. St Ry Rev—Aug. 15, 1897. No. 14655 C.

Hannover.

Electric Street Railways in Hannover. (Ueber die Elektrische Strassen bahn in Hannover.) A paper before the Street Railway Association at Vienna by Friedrich Ross giving the results of experience both with trolley and storage battery systems. 7500 w. Mitt d Ver f d Ford d Local u Strassenbahnwesens—July, 1897. No. 14755 E.

Leipzig.

The Power Plant of the Leipzig Tramway System. (Die Einfuhrung des Elektrischen Betriebes auf der Grossen Leipziger Strassenbahn.) An excellent illustrated description of this fine new power house. 5000 w. Elektrotech Zeitscher—Aug. 5, 1897. No. 14788 B.

Locomotives.

Electric Locomotives. J. J. Swann. Deals principally with their use in elevated and surburban traffic, in which the motors are almost universally placed on the trucks. 1000 w. Mech Wld—Aug. 20, 1897. Serial. 1st part. No. 14907 A.

Melbourne.

The Great Street Railway System of Melbourne. F. W. N. King. Interesting account, with illustrations. 1500 w. St Ry Rev—Aug. 15, 1897. No. 14653 C.

Motive Power.

Electricity as a Motive Power on Elevated Railways. S. H. Short. Describes the performance of elevated trains with steam as a motive power, also the electrical equipment, with data of operation. Ill. 3800 w. W Elec —July 31, 1897. No. 14430.

Motor Cars.

Motor Cars vs. Electric Locomotives. William Baxter, Jr. The subject is discussed and the writer's opinion is that motor cars will be found to be most desirable for all purposes in work on the elevated roads. 4500 w. Elec Wld—July 31, 1897. No. 14453.

Multiple Unit System.

The Sprague Multiple Unit Electric Railway System for the Chicago Alley Elevated Railroad. Illustrated description of this new departure in electric propulsion, with consideration of its possibilities. 4000 w. Elec Wld—Aug. 7, 1897. No. 14535.

Narrow Gauge.

The Narrow Gauge Railway from Eaton Hall to Balderton. (Schmalspurige Kleinbahn von Eaton Hall nach Balderton.) An illustrated account of the Duke of Westminster's 15 inch gauge railway, mainly from English sources. 5000 w. Mitt d ver f d Ford d Local u Strassenbahnwesens—July, 1897. No. 14756 E.

Noise.

The Noise of Street Railways. (Das Geräusch der Strassenbahn.) A discussion of the causes of street railway noises and the methods of moderation, especially in the direction of smoother roadway and better rail joints. 2500 w. Deutsch Zeitsch f Elektrotechnik—July 15, 1897. No. 14780 B.

Paris Railway.

The Definite Project for the Metropolitan Railway of Paris. Notes on the methods adopted for building this system as abstracted from *Le Genie Civil.* 1300 w. Eng News—Aug. 26, 1897. No. 14892.

Storage Battery.

Englewood and Chicago Electric Storage Battery Road. George A. Damon. History and illustrated description of a road now attracting much attention, as it is the first one in this country to have an equipment especially designed for the use of this system. 4500 w. W Elect'n—Aug. 7, 1897. No. 14548.

Suburban Railroad.

The Suburban Railroad Company's System. Illustrated description of this electric railway system of lines, in and near Chicago. 2200 w. W Elec—July 31, 1897. No. 14428.

Subway.

The Glasgow District Subway. An illustrated account of the actual operation of this line. 3500 w. Ry Wld—Aug., 1897. No. 14612 A.

Summer Cars.

Some New Ideas in Elevated Railroad Equipment. Illustrated description of cars built for the South Side Elevated Co., of Chicago, which have met with great popularity. 1200 w. Ry Rev—Aug. 28, 1897. No. 14956.

Train Control.

The Sprague Multiple Unit System. Describes the main characteristics of train being experimentally operated on the track of the General Electric Company at Schenectady. 1600 w. St Ry Jour—Aug., 1897. No. 14463 D.

Tramways.

Electric Tramways with Stationary Accumulators. Ludwig Schröder. Abstract of paper read before the *Elektrotechnischer Verein.* Describes battery and its work. Also describes the Tettnang Electric railway, and the Remscheid. 2400 w. Elect'n—July 30, 1897. No. 14525 A.

Shall Tramways be Constructed and Operated by the Municipality? (Sollen Kommunen Strassenbahnen Bauen und Betreiben.) Discussing the question of Electric tramway franchises from the present German standpoint, showing the difficulties involved in municipal ownership. 3000 w. Deutsche Zeitschr f Elektrotechnik—July 15, 1897. No. 14777 B.

The City of Leeds Electric Tramways. Illustrated detailed description of a successful municipal tramway. 8600 w. Ry Wld—Aug., 1897. No. 14611 A.

Trolley Decision.

The Van Depoele Trolley Decision. George H. Benjamin. The writer thinks the General Electric Company till controls the "so-called trolley invention." 1700 w. Elec Rev—Aug. 4, 1897. No. 14465.

Trolley Wires.

The Suspension of Trolley Wires for Electric Tramways. (Ueber die Aufhängung der Oberleitung bei Elektrischen Bahnen.) A mathematical discussion with special reference to the strains on the wires considered as catenaries. Two articles, 8000 w. Elektrotech Zeitschr—July 8 and 15, 1897. No. 14787 E.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them.

Please mention The Engineering Magazine when you write.

Babcock & Wilcox, Ltd., London: 147 Queen Victoria street.=Excellently arranged and handsomely-bound and-printed catalogue of "Accessories," containing 235 pages of text, illustrations, tables, and index. Section I gives general types of B. & W. boilers; Section II, furnaces for special fuels, smoke-prevention and forced-draught-apparatus, chimneys, and fire-brick; Section III, water-purifiers, boiler-cleaning apparatus, spare parts, and firing tools; Section IV, steam and exhaust pipes, valves, connections, heaters, feed-apparatus, condensers, superheaters, repair tools, etc. The catalogue is very full, and all parts are excellently classified, tabulated for size, and codified for ordering. Comparative tables of weights and dimensions facilitate the ready conversion of English data into continental equivalents.

The Detroit Lubricator Company, Detroit, Mich., U. S. A.=Catalogue (1897) of the various kinds and styles of sight-feed and other lubricators, and steam and hot-water valves, manufactured by this company.

H. W. Johns Manufacturing Company, New York.=Descriptive price-list (August 20, 1897) of asbestos goods.

W. G. Bagnall, Ltd., Stafford, England.=(*a*) Well-bound catalogue of 86 pages, illustrating and describing, with duties, dimensions, and prices, locomotives for all purposes and of all descriptions; also turn-tables, tipping wagons, gas, oil, and stationary engines, boilers, and light railway material of every kind. (*b*) Pamphlet illustrating light railways and equipment supplied by these works.

International Correspondence Schools, Scranton, Pa.=(*a*) Circular of information. (*b*) Blank form for application for enrollment.

Arthur Koppel, London, Eng., and Berlin, Germany.=Illustrated circular of information relating to the issuer's business as manufacturer of portable railway material and patent portable electric railway.

Webster Manufacturing Company, Chicago, Ill.=Catalogue No. XV. An elegant publication, illustrating and describing elevating and conveying machinery, gas engines, machinery for transmission of power and for handling all classes of material in grain elevators, flour mills, sugar refineries, oil mills, mines, and malt houses.

The British & Foreign Metaline Co., Dundee, Scotland.=Leaflets describing "Metaline," an anti-friction metal to be used in bushes and bearings without lubrication, and giving directions for its employment.

Clarke's Crank & Forge Co., Ltd., Lincoln, England.=Card picturing the "Libra" perfect-balance oil engine, and stating its merits and the size in which it is made. The engine is adapted to use on locomotive cranes.

Clayton & Shuttleworth, Lincoln, England.=(*a*) Illustrated catalogue "No. 96" of portable and fixed engines, boilers, and farm machinery; including thrashing machines, straw-cutters, stackers, straw-trussers, baling-presses, grinding-mills, etc. (*b*) Revised price-list of the firm's machinery of all kinds. (*c*) Pamphlet "1723" of "Accessible" centrifugal pumps. (*d*) Pamphlet "1761" of improved patent oil engines. All are well illustrated, with brief descriptions and full tables of sizes.

The Goulds Mfg. Co., Seneca Falls, N. Y., U. S. A.=Illustrated descriptive catalogue of efficient power-pumps for every service.

The Ball & Wood Company, New York.=Large, illustrated, descriptive pamphlet, setting forth advantages and merits of automatic cut-off steam engines manufactured by this company.

Gisholt Machine Company, Madison, Wisconsin, U. S. A.=Elegantly illustrated and printed descriptive catalogue (Catalogue H) of Gisholt lathes and Universal tool grinders.

W. Summerscales & Sons, Ltd., Keighley, England.=A handsome cloth-bound catalogue of 132 pages, devoted to modern high-class laundry machinery of every description. It is well illustrated and excellently indexed, and shows a remarkably full line.

Massachusetts Institute of Technology, Boston, Mass., U. S. A.=Programme of the courses of instruction, with a statement of the requirements for admission, and a list of officers.

The International Correspondence Schools, Scranton, Pa.=Pamphlet entitled "1,000 Testimonials from Students."

Powell & Brother, Boston, New York, Chicago, St. Louis, U. S. A.=Leaflet entitled "Coal Money Burned. Coal Money Saved. The Paul System." Sets forth the advantages of the "Paul system" of heating and drying by steam.

I. P. Frink, New York.=Leaflet setting forth the merits of Frink's patent reflectors for electric lights.

C. H. Haesler Company, Philadelphia, Pa., U. S. A.=Catalogue illustrating and describing portable pneumatic tools. The half-tone engravings illustrating applications of these tools to various kinds of work are particularly fine.

Watson, Laidlaw & Co., Glasgow, Scotland.=Two well-printed catalogues, in stiff covers. (*a*) Hydro-extractors, for drying textile materials of all kinds, as used in laundries, dye-works, etc. (*b*) Brass and copper heating coils, vacuum-pans, concentrators, stills, evaporators, etc., and gun-metal valves, cocks, lubricators, cups, and fittings. Also a handsome, cloth-bound, illustrated catalogue of machinery for the treatment of sugar after boiling, centrifugal machines, pug mills, breakers, coolers, conveying machinery, etc.; and small pamphlets of water-driven centrifugals and "Victoria" and "Empress" cream separators.

John Wild & Co., Ltd., Oldham, England=Pamphlet illustrating, listing, and pricing hauling and winding engines, steam engines, duplex and three-throw pumps, and vertical boilers.

J. H. Wilson & Co., Liverpool, England.=Illustrated descriptive catalogue of locomotive cranes, fixed, derrick, wharf, and coaling cranes, grab-dredges, steam winches, winding engines, and concrete-making machinery.

Wright's Patent Heater Condenser Co., Great George street, Chambers, Westminster, England. =Pamphlet on water-purification, treating of hard and soft water, and purification by chemical processes, and illustrating the Wright process as adapted to manufacturing and boiler plants.

Hyatt Roller Bearing Company, Harrison, N. J., U. S. A.=Illustrated catalogue and price-lists for 1897, of "Hyatt" flexible roller bearings.

Priestman & Company, Philadelphia, Pa., U. S. A.=Pamphlet containing an illustrated description of the "Priestman Safety Oil Engine," which uses common lamp oil for fuel, and setting forth at length the advantages of this simple motor.

American Radiator Company, Chicago, Ill., U. S. A.=Large quarto, elegantly printed, and illustrated descriptive catalogue of "Ideal" sectional portable, and brick set boilers, for steam and hot-water heating.

Drum Engineering Co., Bradford, England.= Pamphlet figuring, describing, and listing, with sizes and prices, the "Johnson's Patent Drum Pump" for gases, liquids, or semi-fluids. The pump has centrifugal motion, positive action, and is either for pressure or exhaust.

Glenboig Union Fire Clay Co., Ltd., Coatbridge, Scotland, office 48 W. Regent street, Glasgow.= Catalogue, with reports on Glenboig fire clay, extracts from authorities testifying to its merits, and many pages of perspective illustrations, in tint, showing shapes and dimensions of fire brick, tile, covers, glass house blocks, special bricks and blocks, retorts, pipes, traps, and connections.

Illinois Steel Company, Chicago, Ill., U. S. A. =Illustrated pamphlet, describing the "Steel" Portland Cement manufactured by this company from blast-furnace slag, stating buildings wherein this product has been used, and containing data of tests, with other information.

Pullman Sash Balance Company, Rochester, N. Y., U. S. A.=Eleventh Annual Catalogue. Illustrates and describes a number of novelties and specialties in the line of builders' hardware.

Grafton & Co., Bedford, England.=Price-list of steam cranes, from two to thirty two tons capacity, with illustrations of machinery in actual service.

Edward G. Herbert, Manchester, England.= Leaflets illustrating and describing (*a*) the "Universal Truth Indicator," for testing whether surfaces of revolution are running true; (*b*) improved beam-trammels, adaptable to serve as inside or outside calipers; (*c*) steel cramps; (*d*) eccentric-grip vice dog; (*e*) Herbert's patent side cramp; (*f*) radial slot face-plate dog; (*g*) breadth and turning gages; (*h*) adjustable screw packings.

Holden & Brooke, Ltd., Sirius Works, West Gorton, Manchester, England.=(*a*) Abridged catalogue of steam users' specialties. A handy pamphlet, convenient for the pocket or for filing, illustrating and describing steam dryers, anti-primers, steam traps, water-ejection and reducing valves, injectors, ejectors, thermo-regulators, circulators, equilibrium, back pressure and foot-valves, strainers, etc. The cuts are so well lettered that the action and mode of connection of each device are apparent at a glance, and an adjoining table gives sizes, capacities, and prices. (*b*) A special pamphlet devoted to steam dryers and anti-primers.

Norton Emery Wheel Company, Worcester, Mass. U. S. A.=(*a*) Illustrated catalogue of the Norton emery and corundum wheels, emery wheel machinery, and specialties. (*b*) Two small pamphlets illustrating and describing the "Bath Indicator" for testing truth and alignment of machine parts.

The Westinghouse Machine Company, Pittsburg, Pa., U.S.A.=Pamphlet illustrating and describing the "Westinghouse" steam engine, and the details of its manufacture, as a business, from the selection of materials, up through the workmanship, testing, regulation, and sale, with an account of the different styles of engines made, and a statement of efficiency.

Todds & Stanley Mill Furnishing Company, and Todd Pulley and Shafting Works, St. Louis, Mo., U. S. A.=Price list of power-transmission machinery and furnishings

Marshall, Sons & Co., Gainsborough, London, and Calcutta.=Illustrated catalogue and price-list of steam engines, boilers, and other machinery, including all ordinary types of engines, small and large, fixed and portable, horizontal and vertical, simple and compound, and of boilers, both separate and with engines.

Johnson & Phillips, Old Charlton, Kent, England.=(*a*) Pamphlet in stiff covers, with good line cut and half-tone illustrations, describing the "Sheba Electric Transmission of Power" for mining purposes in South Africa—about 600 h. p. for five miles. (*b*) A large series of well printed and well illustrated leaflets devoted to electric and other machinery manufactured by Johnson & Phillips, including direct current dynamos, alternators, transformers, lamps, and cable-laying machinery.

The Frictionless Engine-Packing Co., Ltd., Manchester, England.=Leaflets recommending "Karmal" and "Ogden's Patent Metallic" packings.

The J. W. Ruger Mfg. Co., Buffalo, N. Y., U. S. A.—Catalogue, illustrating and describing a line of gas engines manufactured by this company; with data of powers, speeds, dimensions, and weights.

Manlove, Alliott & Co., Ltd., Nottingham, Glasgow, London, and Manchester.=A collection of leaflets between stiff cloth covers, devoted to sugar machinery of every description, from cane mills to vacuum-apparatus and suspended centrifugals, as well as stationary and locomotive engines. The range covers about everything that could be needed on the plantation or in the refinery.

Pease's Tubular Construction Syndicate, Ltd., Stockton-on-Tees.=An originally-designed booklet devoted to iron-trough flooring, wide-span wood and iron floors, non metallic portable houses and roofs, and tubular columns and fire proof casing. Illustrated by sections and perspectives, showing construction and accompanied by blueprints and data of tests.

BOOKS OF THE MONTH

William S. Hall, E. M., C. E., M. S., professor of technical mathematics in Lafayette College. Elements of the Differential and Integral Calculus, with Applications. D. Van Nostrand Co., New York, 1897. Cloth, $2.25.

Notwithstanding the existence of a great number of treatises in nearly every branch of mathematical science, and notwithstanding the fact that the principal branches of mathematics applicable to practical, experimental, and professional work long since reached a point beyond which they are not likely to be much further advanced, new treatises in these different departments are constantly making their appearance. For the most part they contain nothing new, except, perhaps, some modes of presenting to the minds of students difficult points, which methods the author, in his classes, has found valuable as aids in conveying a complete understanding of the subject. It may be admitted that, if such modes of presentation are really valuable, the fact justifies their publication. There is also a praiseworthy tendency among the teachers of mathematical science to increase the practical skill of students in its application by the presentation of numerous practical problems exemplifying the value of mathematical methods in engineering work. This feature is prominent in Prof. Hall's treatise. The method of limits is used for the demonstration of formulas for differentiation. The author deems this method more rigorous than the method of infinitesimals,—an opinion with which many will not agree. He also thinks it is more readily understood than the method of infinitesimals,—a view in which more will concur, but with which we are forced to differ. The comprehension of the true spirit of either method will depend much upon individual peculiarities of intellect, and the preference for one method over the other will generally be influenced by the experience of the student in his approach to the subject, the method used first being the one most liked. Another feature of Prof. Hall's treatise is the prominence given to the more important applications of the calculus; for example, the subjects of maxima and minima radius of curvature, etc. Chapter IX, on the evaluation of indeterminate forms, is an unusually clear exposition, all the more valuable from the large number of carefully-framed and -graded problems involving the presence and use of such forms. The chapter on maxima and minima also contains an unusually clear exposition of principles and a well-selected collection of problems showing the numerous and important applications of this method in mechanics and generally in the constructive arts. We are forced to the conclusion that this is an excellent book, prepared by a thorough teacher, and that it will rank among the best of modern text-books.

JOHNSTON'S "ELECTRICAL AND STREET RAILWAY DIRECTORY" FOR 1897. Containing lists of electric-light central stations, isolated plants, mining plants, street railways (electric, horse, and cable), telegraph companies, district messenger companies, telephone companies, manufacturers and dealers in electrical and street railway apparatus, machinery, and supplies. The W. J. Johnston Co., New York, 1897. Cloth, $5.00.

It scarcely needs saying that the purpose of this compilation is to collect and arrange in a convenient manner such information relative to electrical and street railways as will be useful to all who have, or desire to have, dealings or business connections with the individuals or corporations who carry on this kind of industry. A notice or review of such a book should, therefore, be directed to a statement of the degree of success which has attended the effort, and we are glad to be able to say that this book is rich in all the qualities which make such a work of reference desirable. In the first place, it is the only directory containing this information yet published in America; second, the information is thoroughly up to date; third, the arrangement and classification of the information is such as greatly to facilitate reference; and, fourth, the scope of the book includes not only the electrical and street railways of the United States, but also those in Canada, Mexico, and Cuba, together with much other information indicated in the title. So far as we know, no other directory or directories now published could take its place. The names are arranged alphabetically, according to States, cities, and towns, and manufacturers are classified not only according to States, cities, and towns, but according to business, and also in an alphabetical or finding list. The names of managing officers, purchasing agents, superintendents, etc., of central stations and street railways are comprised in the vast amount of other useful information presented.

Tratman, E. E. Russell. Railway Track and Track Work. With more than two hundred illustrations. The Engineering News Publishing Co., New York, 1897. Cloth, $3.00.

It is believed that no other extant treatise on the subjects named deals with them so comprehensively and thoroughly as they are treated in Mr. Tratman's book. The author, a member of the American Society of Civil Engineers, and an associate editor of *The Engineering News*, has prepared the work especially for the use of railway engineers and road-masters. While this is the case, it is believed that the treatise can be made of service to superintendents and other operating railroad officials. The breadth of the work may be somewhat judged by a summary of its contents. Chapter 1 treats of the importance of the track, and its relations to traffic; chapter 2 treats of cross-sections; chapter 3 of ballast; chapter 4 of ties and tie-plates; chapter 5 of rails. In these chapters the different kinds of ballast, qualities of wood for ties, tie renewals, preservative processes, metal tie-plates, metal ties, history of railway rails, form of section, foreign rails, manufacture of rails, and the life and wear of rails are topics treated, these first five chapters occupying seventy pages. In chapters 6 and 7 rail fastenings and joints in all their variety, and switches, frogs, and switch-stands almost as numerous as fastenings and joints, are comprehensively discussed. Chapters 8 to 11 inclusive deal respectively with fences and cattle-guards, bridge floors, and grade crossings, track signs, tanks, and other track accessories. Chapters 12 to 18 inclusive treat of side tracks and yards, track tools and supplies, organization of the maintenance-of-way department, track-laying and ballasting, drainage and ditching, track-work for maintenance, gage, grade and curves. Chapters 19 to 22 inclusive cover track inspection and the premium system, switch work, bridge work and telegraph work, and general improvements. The remaining three chapters treat of handling and clearing snow, wrecking trains and operations, records, and reports. An appendix presents tables of standard track construction on fifty railways. A second appendix contains a table of train-speeds and distances run. We think this work deserves to, and will, take rank among standard technical railroad literature.

An Elementary Treatise on Heat and Heat Engines. By W. C. Popplewell. The Technical Publishing Co., Lim., Manchester.

It is not easy to write a treatise upon the subject of heat engines which shall be really elementary, for the very good reason that the subject is in itself advanced, and calls for advanced methods of treatment. Something more than a knowledge of elementary mathematics is needed to understand the language in which it must be written, and the expectation that thermodynamics may be taught in words of one syllable, so to speak, is certain to be disappointed.

However, the present work, which is the republication of a series of articles which have appeared in *The Practical Engineer*, fulfils its intention, in so far as it uses no more of mathematics than is absolutely necessary, and avoids as much as possible the too common tendency of writers on thermodynamics to assume a thorough knowledge of higher mathematics.

After treating of the general phenomena of heat, including its nature, and the methods of measurement, chapters are given on air and gas engines, followed by the thermodynamics of the steam engine. While there is nothing new either in the matter or in the general manner of its presentation, yet, as a whole, the treatise as it stands is an acceptable exposition of the modern theory of heat and heat motors in language probably as clear and simple as possible in view of the nature of the subject; and it should prove useful to those students and professional men who have neither time or training to undertake the more formidable works of the great original investigators.

Graphische Logarithmen-Tafeln. Anton Tichy, Ober-Ingenieur der K. K. Oesterr. Staatsbahn. Wien, 1897.

This pamphlet demands attention from the fact that it adds another to the increasing list of attempts to substitute graphical for numerical operations where-ever possible. Briefly, the book consists of a number of adjacent printed scales, consisting of graduations representing respectively the numbers from unity to 10,000 and their corresponding common logarithms. By looking for any number on the one scale its logarithm is found immediately opposite, or *vice versa*, and all the operations which are performed with a table of logarithms can be readily done in a similar manner by referring to these scales. The book also contains graphical or scale tables of logarithmic sines and cosines, as well as tangents and cotangents, these angular functions being given both for the centesimal and sexagesimal divisions of the degree. Since there are nine columns on a page and eleven pages of common logarithms, each page being about eight inches long, the scales correspond practically to a slide rule more than sixty-five feet long, and, in fact, logarithms can readily be taken out, in most cases, accurately to the fifth decimal place. The book can be used in many cases with almost the same facility as the slide rule, except that the arithmetical work of adding or subtracting the logarithms must be performed separately, involving the use of pencil and paper during the progress of a computation; while, especially in some of the later forms of circular slide rules, nearly all computations except those involving addition or subtraction can be performed continuously, no record being made until the final result is obtained. Herr Tichy's work is, however, interesting and valuable, especially as showing the growing tendency toward the use of graphical methods, and for many purposes it will be found convenient, and accurate enough for all practical purposes.

John Perry, M. E., D. Sc., F. R. S., professor of mechanics and mathematics in the Royal College of Science. The Calculus for Engineers. Edward Arnold, New York—London. 1897. Cloth, $2.50.

This book embodies the course of instruction in the calculus prescribed for the students of mechanics and electrical engineering in Finsbury Technical College. Perhaps in no field of engineering has the calculus proved more practically useful than in the field of electrical engineering. In a book specially designed for engineers one therefore expects much attention to be given to electrical problems, and this is the case in the book under notice to an extent entirely unprecedented, so far as we know. The mechanical applications are about equally numerous. The differentiation and integration of x^n, e^{ax}, and sin $a\ x$ are dealt with chiefly for the reason—as the author tells us in the first paragraph of Chapter III—that, "unless one is really intending to make a rather complete study of the calculus, nothing further is needed. Our knowledge of these three functions is sufficient for nearly every practical engineering purpose." But for those who wish to go further Chapter III, which completes the treatise, deals with general differentiation and integration. Both the matter and method of this treatise command admiration, and we regard it as an important addition to any engineer's working library.

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THE EFFECTS OF TRADE UNIONISM UPON SKILLED MECHANICS.

By Hiram S. Maxim.

BY skill in mechanics we mean not only skill in producing an article, but also the skill which enables one to produce it quickly. There are many amateur mechanics, especially among college professors, who are able to turn out exceedingly good work, but the rapidity with which they are able to do so would not be sufficiently great to entitle them to be called skilled mechanics. Skill, therefore, relates to something more than sufficient ability to do the work. Not only should the skilled mechanic be able to do the work and to do it quickly, but he should also be able to execute any work that relates to his profession. For instance, if he is an engine-builder, he should be able not only to fit a crank-pin and bore out a cylinder, but also to do any fitting, turning, or machining connected with a steam engine. Again, a skilled gun-maker must be able to make a complete gun, doing not only the machine work, but also the fitting. A man able to make only one of the minor parts, to work a single machine or a single kind of a machine, or to fit a certain part, is not to be considered a skilled gun-maker. He might be a skilful spring-maker, a skilful filer, or a skilful turner, but not a skilful gun-maker.

At the present time the trade unions seek to specialize work and to put every obstacle in the way of learning more than one thing. I remember employing a very skilful Swiss mechanic. He was not only an exceedingly good fitter, but one of the best men on a planing machine I had ever seen. On one occasion, while working as a leading hand in the fitting shop, it became necessary for him to do certain work on a planing machine. As there was no one on hand to do the

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work, he did it himself, and, in consequence, was warned by the trade union that this would not be allowed. He replied that he was a master of his profession, that he prided himself on being able to work every sort of machine relating to his profession, and that, if the trade union would not allow him to work at his own profession in his own way, or wished to curtail or interfere with his working the tools that he had learned to work as an apprentice, he wished to withdraw from the union—which he did.

During the last twenty years the milling machine has come very much to the front, and is employed to-day on a great variety of work. An unskilled laborer is able to adjust the machine, place a piece of steel in it, and rough it out approximately to the shape and size of the finished article, but it requires both time and skill for the fitter to reduce it to the exact dimensions required. A skilful hand on a milling machine is able, however, to reduce the work to the exact dimensions required, so that little or no filing is necessary, and to repeat the operation with certainty and at a rapid rate. This is the difference between skilled and unskilled labor.

If the United States are to maintain their position as manufacturers of articles of iron and steel, the work must be produced both quickly and cheaply, and, if milling machines are employed, the operator must seek to reduce the work to the exact dimensions required, so as to save the expense of filing and adjusting. But the trade unions look upon this from a different standpoint. In a factory completely under the influence of the union, it was found that the milling was exceedingly bad,—that everything was left large, clumsy, and rough. In order to prove what could be done with milling machines, a certain amount of work was sent to the tool-maker, who did not belong to the union, and he milled the work down to the exact size required, practically dispensing with the work of the fitters. When this work was shown to the trade-union hands, they remarked that it would never do ; it left nothing for the fitters, and what would they do if the millers and machine men did not leave any steel to file off?

When we first commenced to make Maxim guns on a large scale, I had dies made for the drop forgings which left only about $\frac{1}{32}$ of an inch to be milled off. When, however, the place was put under the charge of a trade-union man, he enlarged all the dies, which greatly increased the weight and size of the forgings, and for no other purpose than to give the men more work to do in milling off the superfluous steel. In some cases the drop forgings were made so very heavy that a portion of the steel was cut off on a shaping machine before being milled at all. When the union man was discharged, and a non-union man put in his place, the dies were all reduced again to their original dimensions; and it may be interesting to note that, when these same forgings were sent to a great German manufacturer, he complained that they were too heavy, although there was barely a thirty-second of an inch to be removed by the milling machines.

In order to show the difference between good milling and bad milling, trade union work and piece-work, I will refer to one little part of the Maxim gun. When this part was very roughly milled and left a great deal too large by the union men, it required more than a day for the fitter to file it into shape. At the present time, however, the milling is so accurate that the fitter is able to do fifteen pieces in one day, or twenty times as much as he did formerly.

When Smith & Wesson, the celebrated pistol-makers of Springfield, Mass., wished to show the skill of their workmen, they exhibited a revolver in perfect working order which came direct from the machines, not one part of it having been touched with a file; and, when Ludwig Loewe, of Berlin, secured a large order for similar pistols for the Russian army, he also exhibited a complete pistol which no fitter had ever touched with a file. It is said that the remarkable cheapness of the Winchester rifle is due to the accuracy of the machine-work, little or no expensive filing or fitting being required.

But there is another side to the milling question. When we began to make guns, we employed members of the Amalgamated Society of Engineers on all our tools,—one man to each tool,—and it was surprising how little work we got out of them. They not only ran the machines at a very low speed, but took a very small cut. I had noticed in France that one operative often ran from four to six of these milling machines. On one occasion, finding one of our leading hands, a strong union man, in Paris, I took him into a French shop to show him the rapidity with which the work was turned out. I pointed out to him that the machines were running with double the speed, and that they were taking at least double the cut that they did at our place, while one girl was working six machines, and, instead of getting from eighteen to twenty-four cents an hour, these girls got only about ten cents an hour. On his return to England, he made a most interesting and instructive speech at a trade-union meeting held at Crayford. He pointed out that, whereas the Crayford Works at that time were employing more than three hundred hands, if the men should do as much work as these French women did, only about sixty would be employed. He said he had figured it carefully out, and he asked what in the name of heaven would become of the other two hundred and forty hands. "Shall we allow them to starve?" said he.

On another occasion, finding the chairman of our company in Paris, I took him to the same works, expecting to find the same state of affairs. On entering the room, however, I found that the girls were no longer there. They had been moved into another and a larger room, where each girl, instead of working six machines, was actually working thirteen milling machines, which were running at the time on sheep-shearing appliances to be used in the British colonies. At the present moment we employ boys very largely on milling machines, and each boy, as a rule, takes charge of four machines, but of course it requires great skill on the part of the tool-makers to keep the tools in order, and to adjust the machines so as to turn out accurate work. At the French factory referred to, I found a large room completely filled with automatic machinery, with only two attendants.

The skilled mechanic of the greatest value at the present time is he who is able to produce machines and tools to a large extent automatic, which can be taken charge of by young and unskilled persons. There is no question that the tendency on the continent and in the United States is to produce machines which practically run themselves. A bar of steel is placed in a machine, the machine is started, and the bar is cut up into screws or other objects, the machine performing all the necessary functions automatically. As these machines require very little attention, it is obvious that one hand can take charge of a considerable number. But this again is discouraged in England. If the machine is large, elaborate, and complicated, the unionists insist that it should be taken charge of by what they are pleased to term a skilled hand. I remember that on one occasion several delegates were sent to us by the Amalgamated Society of Engineers with a complaint that we were allowing an unskilled man to work a Brown & Sharpe milling machine. The chief spokesman was a very young man. He said that this machine was of a very high order, and ought by rights to be worked by a man skilled in the art, and not by a mere laborer. We informed him that the man who was operating the machine was indeed a skilled man, that he was able to do the best work done in the place, and that he had worked a milling machine for thirty years, beginning several years before the spokesman himself was born. We asked him if he could do better or quicker work than the man complained of. He said that he did not think he could do it as well. He admitted that the man was able to do the work, but said that technically he was not a skilled mechanic, because he had not served as an apprentice before he was of a certain age. Consequently, no matter what he might do afterwards, or how skilful he might really make himself, he must remain forever technically an unskilled workman, work for lower pay, and be debarred from doing the fine work that he was so well qualified to do. I found that this same feeling existed all over England. We constantly heard of trade unions interfering and striking because a really skilful man was allowed to work an intricate machine.

In the United States trade unionism is confined for the most part to unskilled laborers. I find that very few of the first-class mechanics employed in New England, or even in New York, belong to any union. Each man relies upon himself, and each, instead of attempting to turn out as little work as possible, is really attempting to get ahead of his fellow-workmen ; in other words, each is attempting to beat all the others, either in rapidity or excellence of workmanship, and, as a rule, there is no standard of price, each man being paid in proportion to what he is able to do. The man is considered the most skilful who is able to do the best work in the shortest time. In a large shop like that of Pratt & Whitney, where, say, a thousand hands are employed, it is no exaggeration to say that at least eight hundred of these hands are expecting to rise to the top, each by his own efforts. It is this struggle to excel in work and rapidity of production that produces the incomparable mechanics of New England.

I remember the instructions that I received when I was a boy and working on an engine lathe. My instructor was a Scotch Canadian who had settled in the United States, and he was the most rapid workman that it has ever been my fortune to meet. He said : "If you wish to turn out work quickly on a lathe, and get ahead of the other fellows, give your lathe all the work it will do, and keep it in the cut all the time. Never take a tool out of your lathe unless you have got another one ready ground to put in, and change your tools as quickly as possible. Be sure and run on your belt, and start your lathe as soon as the engine has made its first turn, and never stop your lathe until the engine stops. It matters little what you do yourself, so long as your lathe is at work."

In England, however, at the present time, the lathe-hand dawdles in a minute or two after the engine has started, and, by the time it pleases him to start the lathe, the engine has often been running five to ten minutes, while no man ever thinks of such a thing as grinding a tool and getting it ready while the lathe is still making a cut.

If we consider rapidity as well as excellence of workmanship, I think anyone must admit that the trade unions have a very detrimental effect upon the development of skilled mechanics. There can be no question but what the value of a mechanic to the country in which he lives depends altogether upon the skill which enables him to do work quickly. If we are able in England to do better work than is executed in the United States or Germany, we can hold our own and keep the trade, if we sell at the same price ; but, if our competitors produce an equally good article and put it in the market at a lower price, they will, in time, capture the trade and leave us out in the cold. It is no use to shut our eyes to the fact that good work is being done in other countries, notwithstanding the fact that the trade unions would have us believe that no mechanical work of any value can be executed except in England.

Some years ago, when we had a strike at our Erith Works, one of our foremen made a speech in which he pointed out the fallacy of every man working at his own particular gait. "For," said he, "there are many of us who can easily do three to four times as much work in a day as our weaker and less skilful companions. In a large shop like this, where thousands of men are employed, there will always be found a considerable number of men who are not strong and healthy and who have little skill. These men are able to do only a limited amount of work. If the strong and healthy men do more work than our weaker comrades are able to do, what is to become of our weaker comrades?" He pointed out that, in order to keep these men employed, and to give them a fair chance, it was necessary for the stronger and more skilful mechanics to reduce the output to the rate at which these less favored brethren were able to do it. Evidently a society whose leading lights make speeches of such a character cannot be considered favorable to the development of that kind of skill which enables a mechanic to turn out work rapidly.

Some years ago, finding that the brass-working lathes usually employed in England were of a very poor quality, I purchased some high class lathes in Boston. Though these lathes cost five times as much as the English lathes, the output remained the same. On several occasions I attempted to show the workmen how to use these lathes,—how to take advantage of the many appliances and adjustments provided for the purpose of turning out accurate work quickly,—but all in vain. One day, however, I went to the forge myself, forged out a set of tools, tempered and ground them, and did some of the work myself. This I regarded as a practical demonstration. I proved to the men that, by having proper tools, and taking advantage of the various stops and appliances for duplicating work, I could turn out from six to ten times as much as they had been doing. The man whose lathe I had used thanked me very much, and the next day I saw he was doing quite as well as I had been doing myself. However, at the end of a month he had completely relapsed into his old ways. All the tools which I had made had disappeared, and the output was identically what it would have been if it had been done on a cheap English lathe. Other men were tried, but always with the same result. Absolutely no advantage was to be derived from the use of the new lathe. At first it appeared to me that it was negligence or stupidity, but afterwards I learned that the trade union had remonstrated with the workman, and cautioned him against doing so much work. "If Maxim wants more work done, why does he not get more men?"

The unionist, as a rule, is not a thinking man. If he were a thinking man, he would not belong to the union. It appears to his clouded intellect that there is a certain amount of work that has to be done, anyway, and that this quantity is fixed. Consequently, he looks upon work as something that ought to be nursed and made to go as far as possible. It appears to him that, the more he gets per hour and the greater number of hours he can be employed upon a job, the greater the yield to his society. It never occurs to him for a moment that, if this were carried to extremes in either direction, the whole thing would be changed. For instance, if the cost of mechanical work should be increased twenty-five per cent. in England, the greater part of it would be driven into foreign countries, whereas, if it could be produced in England for twenty-five per cent. less than in other countries, there would be more than enough work for everyone that could be employed in England. If an Englishman were forced to use the same implements and to spin and weave in the manner in vogue in India, he would be unable to produce cotton cloths in England which could be taken to India and sold at a profit, but, with the improved appliances in England, cottons have been made so cheaply as to make native competition impossible in India, except when the same appliances were employed, and for a long time it might be said that England had a monopoly of cotton goods over the greater part of Asia. In this case success did not depend upon the ability to produce a fairly good article, but altogether upon the ability to produce it rapidly and cheaply. Yet it will be remembered that the very instruments employed to enable the English to compete on so favorable terms were fought, tooth and nail, by the weavers themselves.

Anything which serves to curtail or limit the output is not only detrimental to the country, but to the workman himself, and any society which encourages its members to nurse his job and make it last—that is, to dawdle, and to do it very slowly—not only does much to discourage the development of skilful mechanics, but also does great damage to the trade of his country.

It appears to me that trade unions oppose, and always have opposed, the use of machinery which enables work to be turned out quickly and cheaply, and I believe there has never been a machine, apparatus, or system introduced into England which has helped to give her the position which she now occupies as a great manufacturing nation, which has not been opposed tooth and nail by the ignorant and unthinking who make up the rank and file of the English trade unions.

FUTURE SUPREMACY IN THE IRON MARKETS OF THE WORLD.

THE UNITED STATES VS. EUROPE AS A MANUFACTURING COMPETITOR.

By J. Stephen Jeans.

THE insular prejudices and the complacent self-sufficiency of the average Briton have long hindered him from understanding or admitting the possibility of other nations ultimately occupying fields of industrial activity that he has for generations been accustomed to look upon as entirely his own. The earlier prophets of the impending danger were treated with even more than the ordinary amount of intolerance proverbially accorded in their own country to those who do not prophesy smooth things. Here and there, however, a voice was heard crying in the wilderness. Cobden, more than fifty years ago, pointed out that "it was to the industry, the economy, and the peaceful policy of America, and not to the growth of Russia, that politicians and statesmen of whatever creed ought to direct their anxious attention, for it was by these, and not by the efforts of barbarian force, that the power and greatness of England were in danger of being superseded." Lytton, in his "Coming Race," speaks of that American, and notably industrial, progress "in which Europe enviously seeks her model, and tremblingly foresees her doom." For years past the "lights in the window" have shown that British industrial prowess was not so safe as it was supposed to be, and that the threat of American competition on a colossal scale was not a mere phantom. But that possibility has never been brought so near to our inner consciousness as it is at the present time, when almost every branch of our mechanical industry is threatened with competition of the fiercest kind by the United States.

Great Britain is now importing American pig iron, American steel rails, American wire, American agricultural machinery, American machine-tools, and many other American products. The aggregate value of these importations must be very considerable. I know of one case where a single firm imported last year, in six months only, American machinery, including machine-tools, to the value of nearly £150,000. That this competition has come to stay appears to be generally admitted. The conditions and prospects of American competition appear, indeed, for the moment, to overshadow every other industrial problem, except that of labor, with which it has a closer affinity than is usually supposed, and to call for the most serious consideration.

It is one more example of how history repeats itself that England should to-day be witnessing so remarkable a development of competition with the United States. It will probably be among the things not generally remembered that American competition in the iron trade was a *bête noir* of Englishmen in the last, and in the early part of the present, centuries, although under very different conditions. In the first half of the eighteenth century the iron trade of Great Britain was in danger of extinction, because of the exhaustion of supplies of timber, upon which the trade then depended for fuel. Indeed, it began to be feared that, owing to the large amount of timber required for the manufacture of charcoal to feed the furnaces of that day, "there would not be oak enough left to supply the royal navy and mercantile shipping."

It was under these circumstances that efforts began to be made to stimulate the importation of iron from the then British colonies of North America. The then house of commons, however, looked only to the interest of the mother country, and treated the colonists in this, as in other matters, with an absence of consideration that has had its aftermath in many episodes of more recent times. They were to be permitted to produce pig and bar iron, because it suited the needs and extremities of the mother country that they should do so, but they were "not to manufacture iron wares of any kind whatsoever, under certain penalties." *

Not more discreet was the action of the house of lords, which added a clause to the effect that "no forge going by water, or other work whatsoever, should be erected in any of the plantations, for making tows, pigs, or cast iron into bar or rod iron." This provision does not appear to have come into effect at the time, owing to the conflicting interests involved—the merchants promoting, and the iron manufacturers opposing, the free import of American iron into Great Britain. But an act was passed in 1750, which provided that no works or mills should be permitted in the American colonies for the manufacture of iron or steel. The colonies, in fact, were absolutely interdicted from taking such action as would enable them in any way to compete with the mother country.

At the present time, as we have indicated, there is no individual influence that is causing more apprehension as to the future of the iron trade of Great Britain than the growth of American competition. As yet, the danger does not appear to be serious,—not at any rate in its actual extent. Probably a large majority of those who have not had the opportunity of studying the conditions have hardly realized that there is any danger. In truth, it is difficult to suppose that there can be much menace to Great Britain's industrial status on the part of a country which is not only more than three thousand miles distant from our own shores, but which has to assemble the raw materials for her manufactures from distances varying from a hundred to a thousand miles, by lake and railway, before she can begin to manufacture, and which, by geographical conditions, is practically compelled to carry on her manufacturing operations, not on the seaboard, as is usual in Great Britain, but far in the interior, at distances varying from two hundred and fifty to five hundred miles from the sea.

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* Provision of bill introduced into parliament in 1719.

It would naturally be supposed that the establishments on the Atlantic seaboard of the United States were most likely to attempt competition with the mother country, or to succeed in the attempt. Such, however, has not been the case. The most formidable form and extent of competition has come from the neighborhood of Pittsburg, four hundred and fifty miles from New York, where the great Carnegie company has constructed, and keeps in operation, three or four of the most remarkable establishments of their kind in existence, and undertakes the manufacture of iron and steel in a great variety of different forms. This phenomenon is not more singular or interesting than the career of the man whose name the enterprise bears, and we may, therefore, be allowed to digress for a moment to speak of that career, as illustrating at once the conditions and the possibilities of industrial development on the western side of the Atlantic.

Andrew Carnegie, the founder of the firm whose operations are now regarded as a menace to Europe, is the son of a working weaver, and was born at Dunfermline, in Scotland, about sixty-four years ago. He commenced work at ten years of age as a piecer in a textile factory ; then became successively a boiler-mender, a telegraph messenger, and a telegraph operator. He emigrated to the United States in 1847, becoming connected with the Pennsylvania Railroad, and in that capacity was enabled to realize the importance of having local supplies of steel rails, which were then being imported to a considerable extent from Europe for American railroad construction. Through the intermediation of some friends, he was enabled to acquire an interest, first in a small forge, next in some bridge works, and finally in the larger works which were founded by the late Edgar Thomson, late manager of the Pennsylvania Railroad, for the purpose of manufacturing iron and steel for railway purposes.

The Homestead works and the Duquesne furnaces followed the Edgar Thomson, and these were aided and abetted by the Keystone Bridge Works, giving the firm the supreme control of four of the largest and best equipped establishments on either side of the Atlantic.

It seems ridiculous, on the face of it, to speak or think of a single firm as offering a menace to the industry of a whole continent, when that industry is one so vast and universal as the manufacture of iron and steel, and that continent happens to be Europe, where modern industry has hitherto been supposed to have had the most favorable conditions for large and successful development. It appears all the more ridiculous when we bear in mind that the rival works of Europe, for the most part, have the raw materials within a hundred miles of each other, and within twenty miles of the sea.

A few figures will make this danger more appreciable. The Carnegie company alone produces nearly two million tons of pig iron per annum, which is almost as much as the total joint output of Germany, France, and Belgium thirty years ago, and more than the total iron output of the United States up to the year 1872. The same works produce annually about a million tons of bessemer steel ingots and six hundred and fifty thousand tons of rails,—figures which exceed the annual output of all the works in Great Britain up to 1880,—and the same firm has lately made arrangements to produce at Homestead about a million tons of open-hearth steel annually, which is more than the total open hearth steel output of France, Belgium, and Germany combined, and considerably more than the total output of this description of steel in the United States, as a whole, up to 1894. And this gigantic corporation does not stand alone. The Illinois Steel Company has also much larger resources of production than any concern in Europe, and so also has the Tennessee Coal and Iron Company in another and not less interesting region. Of corporations in the second rank, but still important and formidable, the number is legion.

We may now proceed to consider some of the conditions that differentiate European, and, more particularly, British, from American competition, with a view to the ascertainment of how far either enjoys superiority of present position or future prospects as compared with the other. This inevitably leads us to a consideration of the general conditions and resources on which manufacturing supremacy reposes, and to which both countries must look for the maintenance of their industrial status.

The essential elements in the success of manufacturing competition may be thus classified :

1.—Abundance of cheap raw materials of good quality.
2.—Favorable conditions for manufacturing near to shipping ports.
3.—Cheap transport by land and water, but especially by land.
4.—Economical, but not necessarily nominally cheap, labor.
5.—Efficient technical equipment.
6.—Facilities for ready and economical distribution of products.

These conditions, again, are divisible into those that are special to particular countries or localities, and those that are common to all.

In one respect, the United States appear to enjoy conditions which are unapproached in Great Britain, but which happen to be at once vital and fundamental. They have the most ample abundance of cheap and high-class ores at an extremely low price. In the northern States of Michigan, Minnesota, and Wisconsin, commonly spoken of on both sides of the Atlantic as the Lake Superior region, the American iron trade commands the largest supplies of high-class ores known to exist in the whole world. These ores occur under conditions which admit of their being mined at a lower cost than is known anywhere else. They have, however, one great natural drawback; they are hundreds of miles from suitable fuel. A quarter of a century ago this fact would have hindered their economical use in the iron industry, and actually did produce that effect, until the problem of cheap transportation had been solved. There remained the question of whether the ore should be carried to the fuel or the fuel to the ore. Nature seemed to have dictated the reply. At Pittsburg, at the junction of the Ohio with the Allegheny and Monongahela rivers, on the most productive coal-field in the new world, and having all the advantages of a great railroad center, and of numerous subsidiary industries, there were manifestly unexcelled facilities for distribution, and thither, therefore, the steps of some of the pioneers of the modern fabric of American industry were directed. Others, again, adopted Chicago as a more suitable center for manufacturing operations, although nearly five hundred miles from both the ore and the fuel, because of its importance as a market and a distributing center, and because of the ready command of effective labor. A third group adopted Philadelphia as a manufacturing center, because it was near to shipping facilities and a dense population, and suitable alike for fuel supplies and for export trade. A fourth group of works located at and around Birmingham in Alabama, obviously because on that particular spot the iron ores and the fuel could be assembled within a radius of twenty to thirty miles, although the nearest port for shipment was two hundred and fifty miles distant, and there were no large local markets near at hand. Of the numerous minor groups of works in the United States it is hardly necessary to speak, beyond remarking that there is every likelihood of a considerable iron industry springing up on Lake Erie, at or near to the beautiful modern city of Cleveland, where materials can be assembled at a relatively cheap cost, and a reasonable export rate is possible *via* the Erie canal.

The most important of these groups depend on the ores of Lake Superior, as mined in the Mesabi, the Vermilion, the Gogebic, and other ranges, and during the last few years have been having 60 to 65-per cent. ores delivered at works, after a railroad transport varying from 40 to 150 miles, and a lake transport varying from 500 to 850 miles, at three to five dollars per ton, whereas no British works can command such ores at anything like the lower figure named. The Alabama and Tennessee works command a 40 per cent. ore at 2s. 6d. to 4s. 6d. per ton at the furnaces, which is under the prices paid in the Cleveland and other cheap low-grade ore districts in Great Britain, and in Germany and Belgium for the oolitic ores of Luxemburg and Lorraine.

So far as labor is concerned, the achievements and the experience of the United States have completely upset the fallacy that highly-paid work is necessarily dear. On the contrary, it has been made evident that nominally dear labor is the cheapest of all, if its efficiency be guaranteed by proper methods and appliances. There are no works, either at home or abroad, where ores, coal, pig iron, and steel ingots, or steel girders, rails, and beams, are being made at so low labor cost, per ton of product, as in the United States; and yet there is no iron-making country in which the nominal wages paid to labor are so high. The explanation of this paradox consists in the fact that the American workmen do not, as is but too usual in Europe, and especially in Great Britain, resist mechanical improvements, but rather welcome them, as assisting to get rid of the most irksome and laborious part of their duties. Most of the operations are conducted automatically by machinery of a novel and ingenious character, which British manufacturers, I have reason to believe, hesitate to introduce at home, because of possible difficulties with their workmen.

In their dealings with their workmen, as in all other operations involved in the conduct of their colossal undertakings, the Carnegie Company, which I select as a type of American methods, has adopted a firm and determined, yet not aggressive, attitude, which would, I fear, be declined by even the largest concerns in Great Britain. In a communication which I have received from Mr. Carnegie, he explains that their system has been to run their works, as regards labor, on a three-years' sliding scale, the basis of which has been a matter of tri-yearly settlement. Each month a committee appointed by the workmen visits the offices, and is shown everything connected with the contracts executed or pending, being at the same time supplied with a statement showing the net prices received for the work of the previous month. These prices govern the wages paid in the following month.

Of course, the system, however well devised, has now and again been on the verge of break-down by reason of changes introduced into methods or systems of manufacture. Now and again, for example, the Carnegie Company has taken advantage of newly-designed labor-saving appliances, and hence has raised the issue of what the effect of such a change should be on the previously-existing arrangements with their workmen. This company, on the expiration of the three years' scale in January, 1892, submitted a proposal to divide equally with their workmen all the increase of profits or net earnings due to improved methods. The proposal was accepted by the workmen at the rail-mills, but was declined by those at Homestead, and hence the memorable strike of that year, the exact circumstances of which were greatly misunderstood.*

Efficient technical equipment has been spoken of as one of the essential elements in the success of manufacturing competition. Until a comparatively recent date, Great Britain stood unrivalled from this point of view, and was, indeed, *sui generis* as a manufacturing nation. But the economic policy adopted by the United States—and which is often supposed to cramp and fetter invention—did not hinder a band of brilliant engineers and metallurgists from exerting themselves to improve upon British methods and appliances, until they placed American practice far ahead of anything in Europe. It is hardly needful to multiply examples of this well-known fact—a part, by the way, seldom disputed now even by the most conservative of British manufacturers. American methods enable much larger yields to be obtained from a given plant, alike in iron-works and in steel-works, and generally at a lower labor-cost. Fortunately for Great Britain, she has awakened to the importance of getting abreast of American practice, and is now endeavoring—although still, as a rule, at a more or less considerable distance—to approach, or rival, America's mechanical achievements.

Again, it goes without saying that facilities for the distribution of manufactured products are greatly helpful, if not fundamental, in the maintenance of industrial supremacy. So far as foreign or export trade is concerned, no country should be better off in this respect than Great Britain. Nevertheless, it seems to be the fact that high railway rates, and the arrangements made by shipping conferences, have deprived that country of a great deal of the superiority which unrivalled geographical situation should guarantee. Even these conditions, however, do not prevent Great Britain from using the facilities which she enjoys as a nation owning and controlling one-half of all the shipping tonnage of the world, and her export trade in manufactured commodities is still consequently larger than that of any other country. In the absence of similar facilities, the United States stand at a great disadvantage. They cannot always command tonnage, and they cannot control freights as can Great Britain. This disability is likely to remain, while the American marine, on the over-sea register, remains so greatly inferior to the British merchant navy, as it now is.

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*The truth is that the Carnegie Company asked only that the "tonnage" men, who numbered only 300 out of about 3,800 in and around the works, should divide these increased net earnings. The attitude taken by the firm has been described as an attack upon organized labor. It was nothing of the kind. It was only a stand made for freedom of contract, and resistance to violence. But the trouble given by the union workmen was so great that the company has since largely worked its plants with non-union labor.

Perhaps, however, the more immediate cause of the industrial movement which has now alarmed Europe so seriously is the recent development of the new ore deposits in the Lake Superior region, which has placed at the disposal of certain manufacturers raw materials of exceptional richness, at a price that would not have been deemed possible only five years ago. Although I shall return to this subject, I may here remark that, according to the American census of 1880, the average spot value of all the ores mined in the United States in that year was 12s. per ton, and the average of the Lake Superior ores was 13s. 7½d. per ton. A dollar and a half more, or, say, 6s. per ton, would be required to place these materials alongside furnaces in the Pittsburg district, so that the average cost of a ton of Lake Superior ore, at the furnaces in Pittsburg, would not be less than 19s. per ton, and the average cost of the single item of ores, per ton of iron produced, would be about as much as the total cost of producing a ton of bessemer pig iron in the same district, according to the most recent figures. This cost is now considerably under the average of the European, including the British, iron-making centers, producing the same description of iron.

This extraordinary change has been brought about, partly by the opening-up of the new Mesabi iron range, partly by improved methods of working and distributing the ores, and partly by large reductions in the cost of transportation. It is claimed that over a large area the Mesabi ores can be put on trucks at the mine for only 7d. per ton, excluding royalties, as against 13s. 7½d. for Marquette ores—then almost the only ores worked on a large scale in the lake region—in 1880, and the ores are almost of equal richness. The distance over which these ores have to be carried, in order to reach the blast furnaces for which they are destined, is, of course, very considerable, but, by conducting operations on a specially large scale, and studying every practicable economy, the cost of transport has been reduced to little more than a dollar a ton for an average haul of about eight hundred miles, which is probably the lowest rate that has ever been known, on a practical basis, in the history of modern transport.

Briefly, this cheap transport may be here ascribed to a relatively low capital cost; to the use of powerful locomotives, capable of hauling very large loads; to the employment of trucks that carry thirty to forty tons each, against a capacity of eight to ten tons in British trucks, thereby securing a relatively large paying load; and to numerous minor economies. I may here add that the average cost of railroad transport in the United States is estimated at not more than one-third of the average in Great Britain.

So far as the question of the problematical continuance of the present low range of prices is concerned, it must not be overlooked that each succeeding period of depression in the history of the American iron trade has discovered a lower depth, in what was previously deemed to be the lowest depth possible. Take bessemer pig iron as a case in point,—this being virtually the basis of the American iron and steel industry. In the period 1873–79 the lowest price known for this product was $19.50, and that price was then deemed to be all but impossible. In the next serious depression, 1884–85, the price of $17 was reached; and in the period 1891–94 the lowest price was $10.50. But during the last twelve months considerable quantities of bessemer pig iron have been sold for less than 40s. per ton, or 6 to 8s. per ton more than European rates; and it is claimed that under present conditions pig iron can be made at Pittsburg for less than 35s. per ton, or, approximately, 10s. per ton below its estimated cost in Europe. It has been much the same with other leading commodities—steel rails, for example, having been regarded as phenomenally low at $40 in the period 1873–79; at $26 in the period 1884–85; and at $24 in 1891–94, but being now sold at $17 per ton, or less, at works in Pittsburg.

I have said that American practice has confounded the wisdom of those who have hitherto argued that nominally cheap labor is needed to secure an absolutely cheap product. It has equally upset the old-fashioned ideas about the effect of protection in favoring the producer at the expense of the consumer. No doubt, under ordinary circumstances, and especially in the infancy of industry, this result happens. It may also sometimes happen, and remain, after an industry has been fully established, when the conditions are not favorable to cheap production as a result of internecine competition. It has happened also, and will probably happen again, as the result of artificial interference with the free play of competition between the works established in the country whose industries are supposed to be protected. But over a wide range of industrial operations protection does not protect, and this paradox was never more clearly apparent than in the existing condition of the American iron industry. For that industry at least the United States require the shackles of protection no longer. I am disposed to doubt whether the same remark is equally true of European countries.

MODERN WHARF IMPROVEMENTS AND HARBOR FACILITIES.

By Foster Crowell.

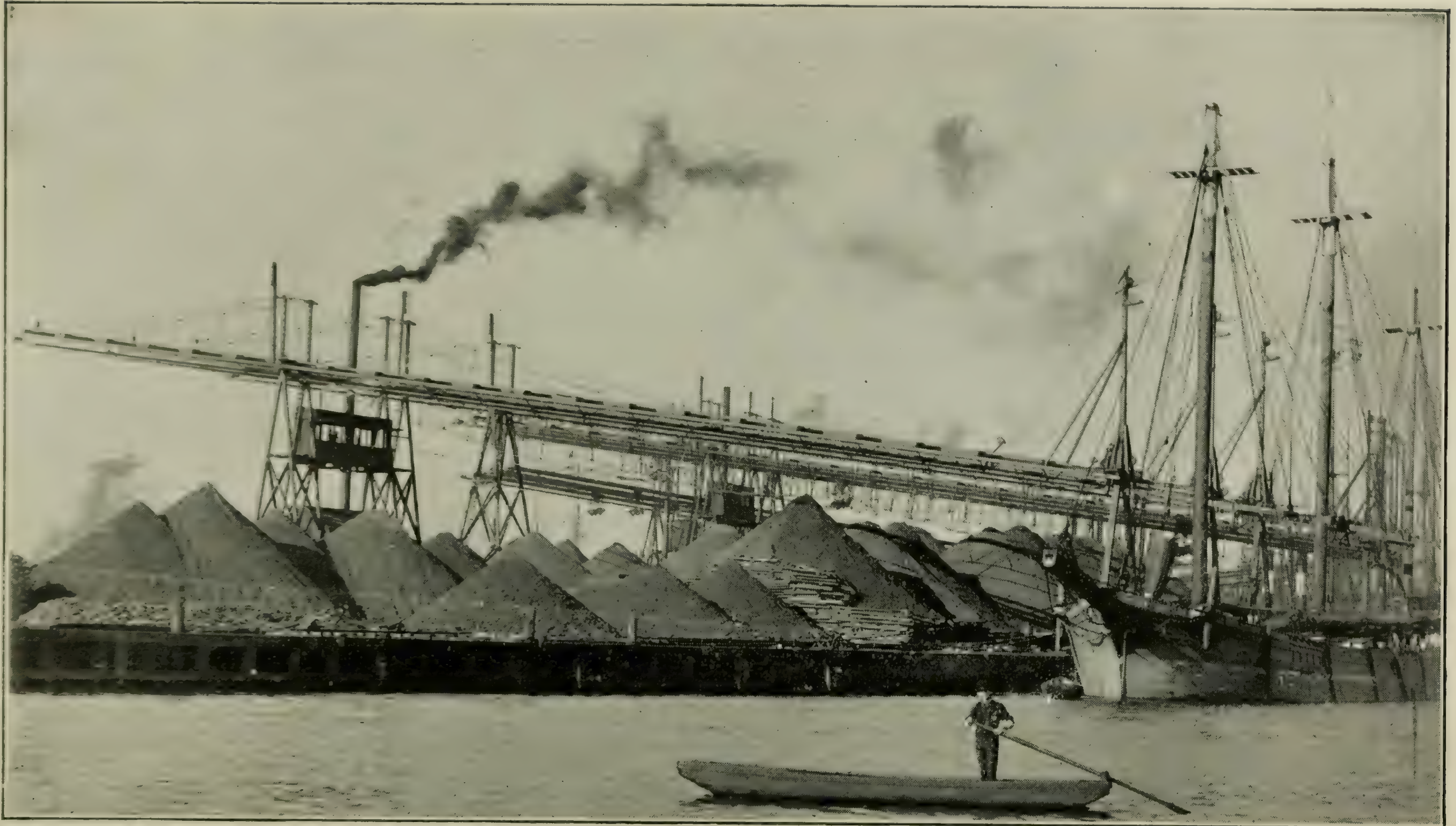
II. EXPANSION OF DOCKS, WHARF SHEDS, AND MEANS OF TRANSPORTATION.

IN the first paper of this series (published in the October number) various kinds of maritime plants for handling miscellaneous cargoes were described and illustrated ; we come now to the development on a larger scale of typical apparatus for handling commodities in large bulk, wherewith great rapidity of action and low cost of operation can be attained.

In the matter of cost of operating wharf plants it is not to be understood that the same degree of economy which can be reached in the handling of a particular commodity in large bulk, such as coal, or grain, or ore, can be attained with miscellaneous cargoes ; the difference in cost per ton may be enormous. For instance, there are plants in successful operation at Charleston and other places, for unloading sulphur, barytes, and other bulk stuff, at a cost of less than two cents per ton, including the entire movement from the vessel's hold to the storage bins, several hundred feet away from the wharf, and thence through chutes to the cars ; whereas the cost of handling a miscellaneous cargo, even under the most favorable circumstances, ranges at present from thirty-five to ninety cents per ton between hold and wharf. It is in the methods of dealing with general cargoes that the greatest field for improvement exists ; this is not a stevedore's, but an engineer's problem, and it embraces things other than the actual placing of the goods ; it involves their sorting and distribution, and must be adaptable to all sorts and conditions of freight.

Coal can be handled very cheaply ; under certain conditions hard coal can be put into a vessel for less than one cent per ton ; but the best performance in New York harbor in coaling a ship at the wharf used for miscellaneous traffic costs from twenty to twenty-five cents per ton. A fortune awaits the inventor who can devise a practical and economical mechanical means of loading steamer coal in the condition in which it comes to market,—a mixture of large lumps and fine dust and all intermediate sizes and shapes.

In the lake ports and at some seaports—wherever coal can be brought direct from the mines to the ship's side in the cars—the problem of coaling is much simpler. Plants are in use where the loaded car is run into a side-tipping cradle placed at a higher eleva-



MOVABLE BRIDGE-TRAMWAY HOISTING AND CONVEYING APPARATUS, FOR THE RAPID HANDLING OF COAL AND ORE, IN USE ON THE C. & P. R. R. CO.'S DOCK, CLEVELAND, OHIO.

Built by Brown Hoisting and Conveying Machine Co. Clear span, 180 feet. Cantilever extension, 80 feet. Hinged projection over vessel, 34 feet. Total length of tramways, 300 feet. Height above dock—front piers, 30 feet, back piers, 53 feet.

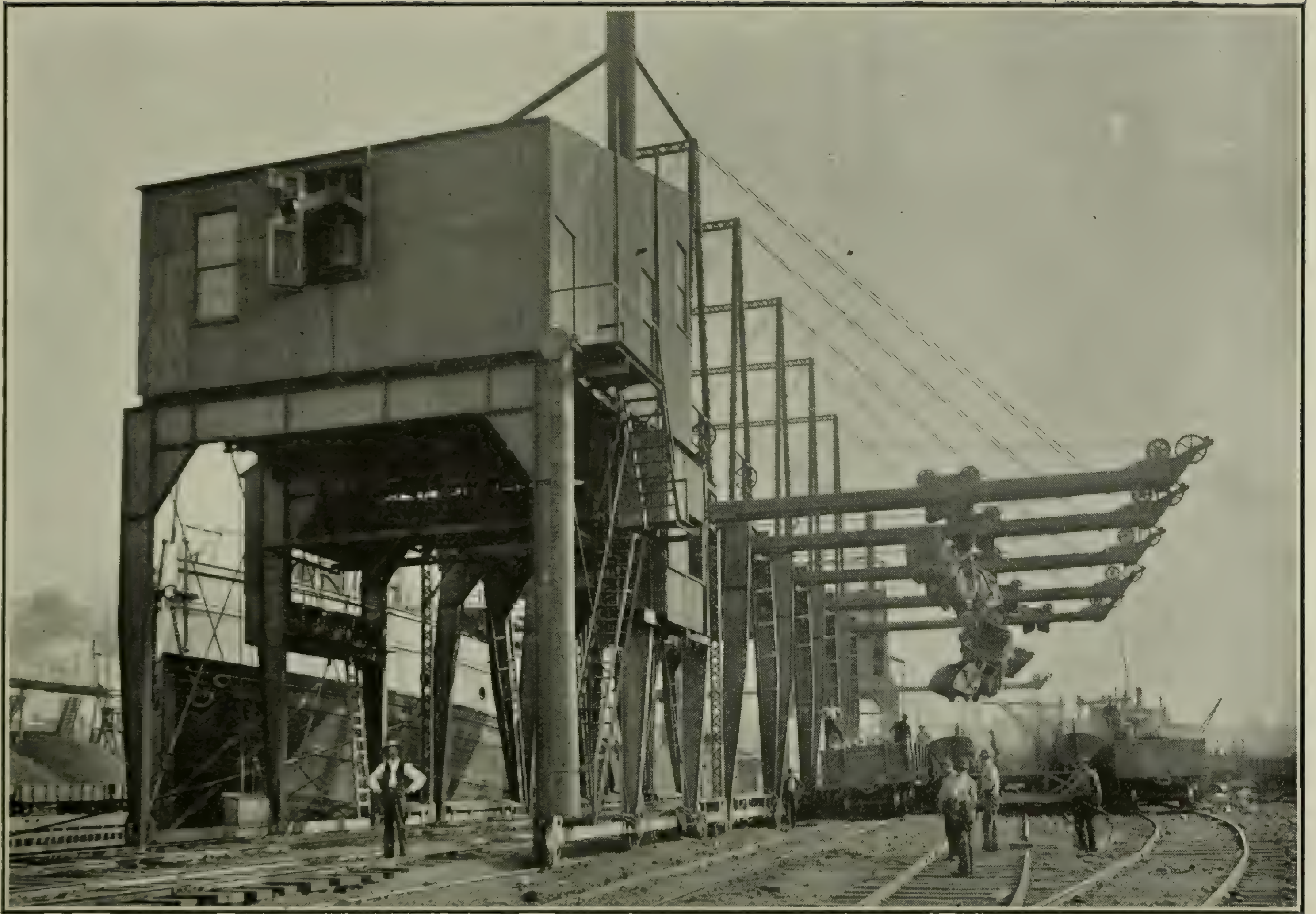
tion than the ship's hatches, and the cradle is then revolved in a vertical plane, discharging the entire car load in an instant into the hatch, the complete operation requiring about three minutes per car, on an average,—a rate of twenty cars, or five hundred tons, per hour. There are other forms of tipples similarly used, and also arrangements for drop-bottom cars.

The statement has been made that a lake propellor some time ago unloaded 3,000 tons at Erie, steamed to Ashtabula, forty miles away, and took on 1,800 tons of coal, entering and clearing at both places in one day ; it is also claimed that 5,000 tons have been loaded at one wharf in twelve hours.

As is the case always with machinery, the theoretical minimum of cost of operating can be reached only when the machine is worked full time ; therefore figures of unusual performances must be weighed with care. It may be said that the cost at the lake ports by the old methods is about twenty-five cents per ton from car to hold,—just about the same as the cost from barge to bunkers in New York harbor.

The Brown Hoisting and Conveying Company, of Cleveland, has kindly furnished me figures, collected by the superintendents of various companies using their forms of apparatus, of the cost of work done by their bridge tramways, handling ore and coal from vessel to dock, as well as from cars to vessel ; these reports extend over several years, and embrace more than fifty loadings of various steamers and other vessels in the lake trade, with cargoes of ore and coal ranging from 4,569 tons down to 1,016 tons, at the ports of Cleveland, South Chicago, West Superior, Erie, Fairport, and Duluth. A comparison of the figures shows that the largest single cargo was unloaded in 11 hours at the rate of 415 gross tons per hour, and that the average hourly rate of all was 226 gross tons. The cost per ton cannot be properly averaged in the same way, but, from an actual account of the expenses of operation, carefully kept for an entire season, of a plant consisting of three bridge tramways, it is found that, worked only three-fourths of the number of working days, at a rate of 1,000 tons per day for the three, the cost would have been 1.6 cents per ton; if the machines had been worked every day, the cost would have been reduced to 1.32 cents per ton. The illustration on page 206 shows the Brown bridge tramways in operation. On page 208 is shown another form of the Brown movable conveying apparatus in use on the C. & P. R. R. Company's docks at Cleveland, Ohio.

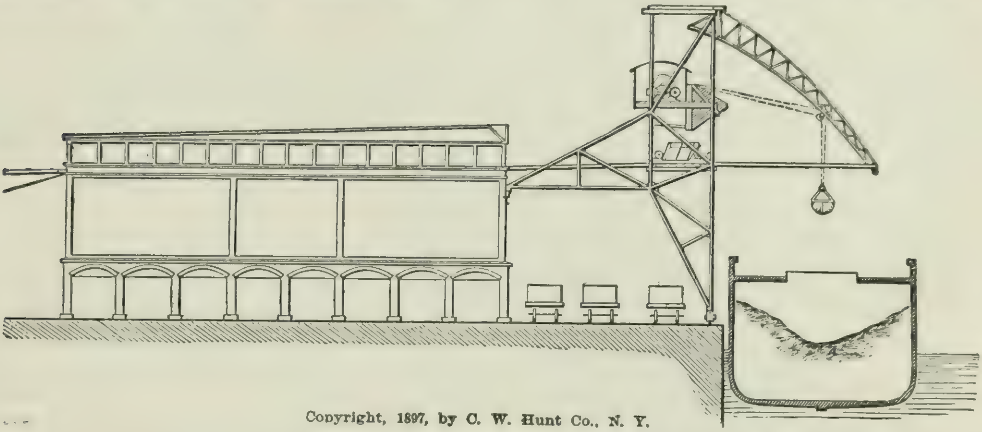
The longitudinal section shown on page 209 gives a very clear idea of the method used by the Danish Coal Company at the new free port of Copenhagen, the apparatus being designed and manufactured by the C. W. Hunt Company, of New York. The coal is received in



CONVEYING APPARATUS FOR THE RAPID HANDLING OF COAL AND ORE, IN USE ON THE C. & P. R. R. CO.'S DOCKS, CLEVELAND, OHIO.

The Brown Hoisting and Conveying Machine Co. Tramway projection over vessel, 30 feet. Cantilever extension over tracks, 33 feet. This plant extends over four railroad tracks, so that cars can pass beneath. The entire plant is movable parallel to dock front.

ships, and is removed by means of the steam shovel, operated by a specially constructed hoisting engine, shown in the illustration on page 211. The shovel has a capacity of two tons of coal at each load, and a round trip to the hopper in the tower and return to the boat is made in less than one minute. The shovel is hoisted by a flat-link chain, composed of eight side-by-side links, each link being stamped from special flat steel, and the chain has a tested strength of 62,000 pounds, while the total strain in practical working is from 8,000 to 10,000 pounds, giving an ample safety factor. The use of this chain eliminates all possibility of accidents from defects in welded links, such as are occasional with crane chains. The elevators are movable the whole length of the wharf, one leg resting on a rail on the wharf and the other on a track placed on the coal storage building, leaving unobstructed space for three railway tracks. They are arranged so that the coal, when hoisted from a vessel, can be carried into the building by the over-head automatic railway, whence it can be spouted directly into railroad cars underneath on the wharf; or it can be dumped into a lighter on the outside of the coal vessel. There are four of the elevators and engines in the plant, similar to the one shown. The engine illustrates the type especially designed and adapted for this purpose. There are two cylinders, each 12 inches in diameter and with a stroke of 14 inches. The reversing valve-gear is the "Hackworth," and is simple and efficient. The chain winds up on itself on the drum in a spiral as flat as a wire rope, and almost as noiselessly. The umbrella-shaped drum at the left of the engine holds the wire rope for raising and lowering the counter-weight to balance the weight of the shovel.

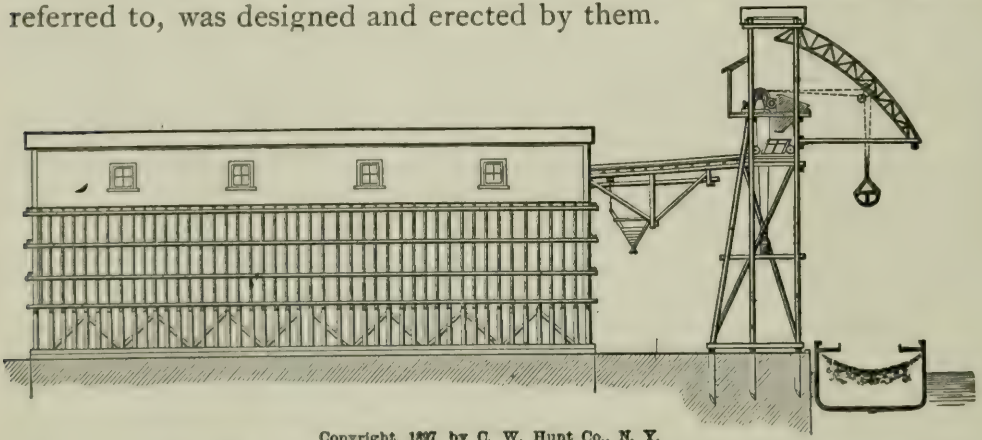

Copyright, 1897, by C. W. Hunt Co., N. Y.

COAL-HANDLING PLANT OF THE DANISH COAL CO., NEW FREE PORT OF COPENHAGEN.

After the coal is dumped into the hopper in the tower, the automatic car, with a capacity of one shovel-load of 2 tons, carries it, by gravity, to any desired location in the coal-storage building, dumps there its load automatically, and returns to the starting-point without any manual labor, the entire trip occupying about thirty seconds.

A somewhat similar arrangement, shown by the section below, and also illustrated by the view on the opposite page, is that used by Mr. J. T. Story, at Morgan and Johnson avenues, Newtown Creek, Brooklyn. This, too, was designed and erected by the C. W. Hunt Company. It differs from the Copenhagen plant chiefly in respect to the elevator, which is not movable. The shovel carries two tons of coal, and makes a trip a minute.

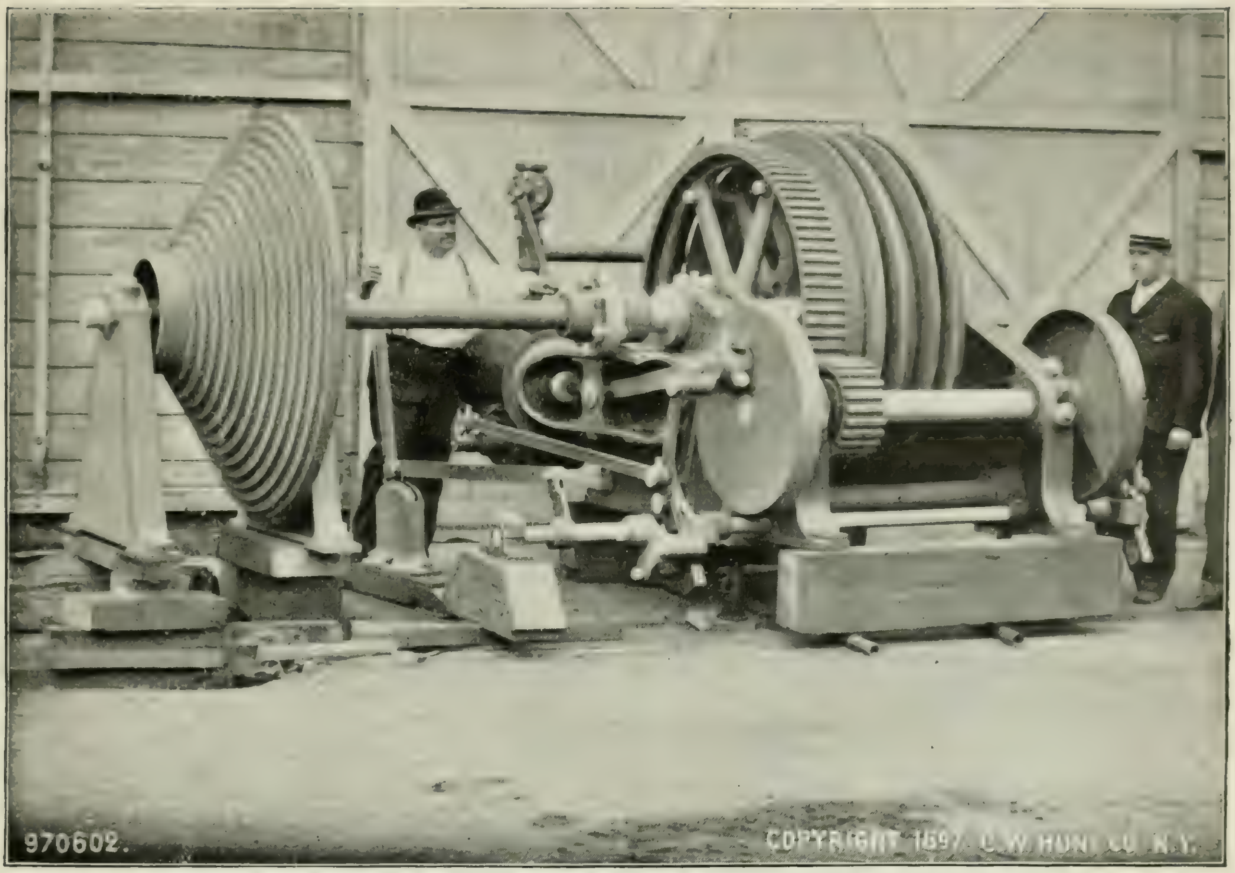
The automatic method of returning the car to the loading point, after automatical dumping at any desired point, has been applied by the C. W. Hunt Company to handling various commodities besides coal. The plant at Charleston, for unloading sulphur, etc., above referred to, was designed and erected by them.



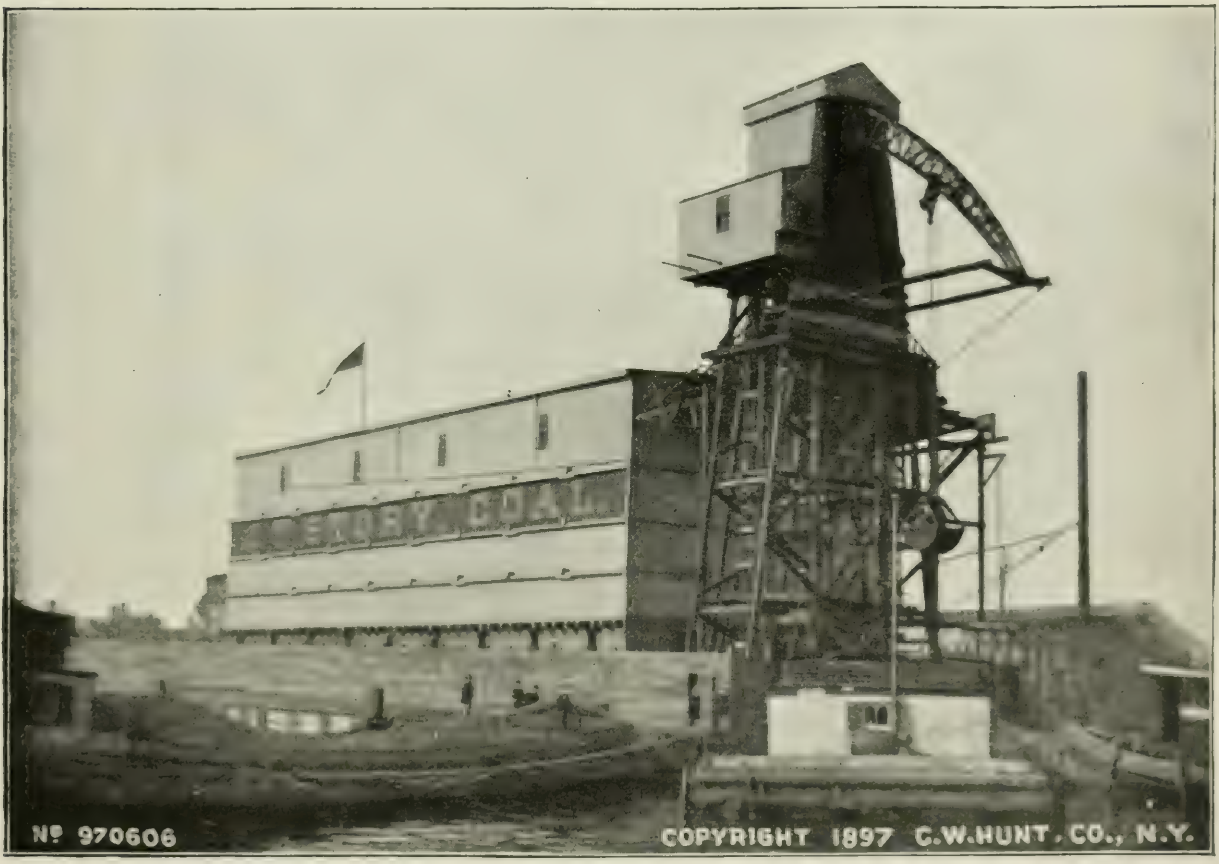
Copyright, 1897, by C. W. Hunt Co., N. Y.

NEWTOWN CREEK COAL-HANDLING PLANT, BROOKLYN, N. Y.

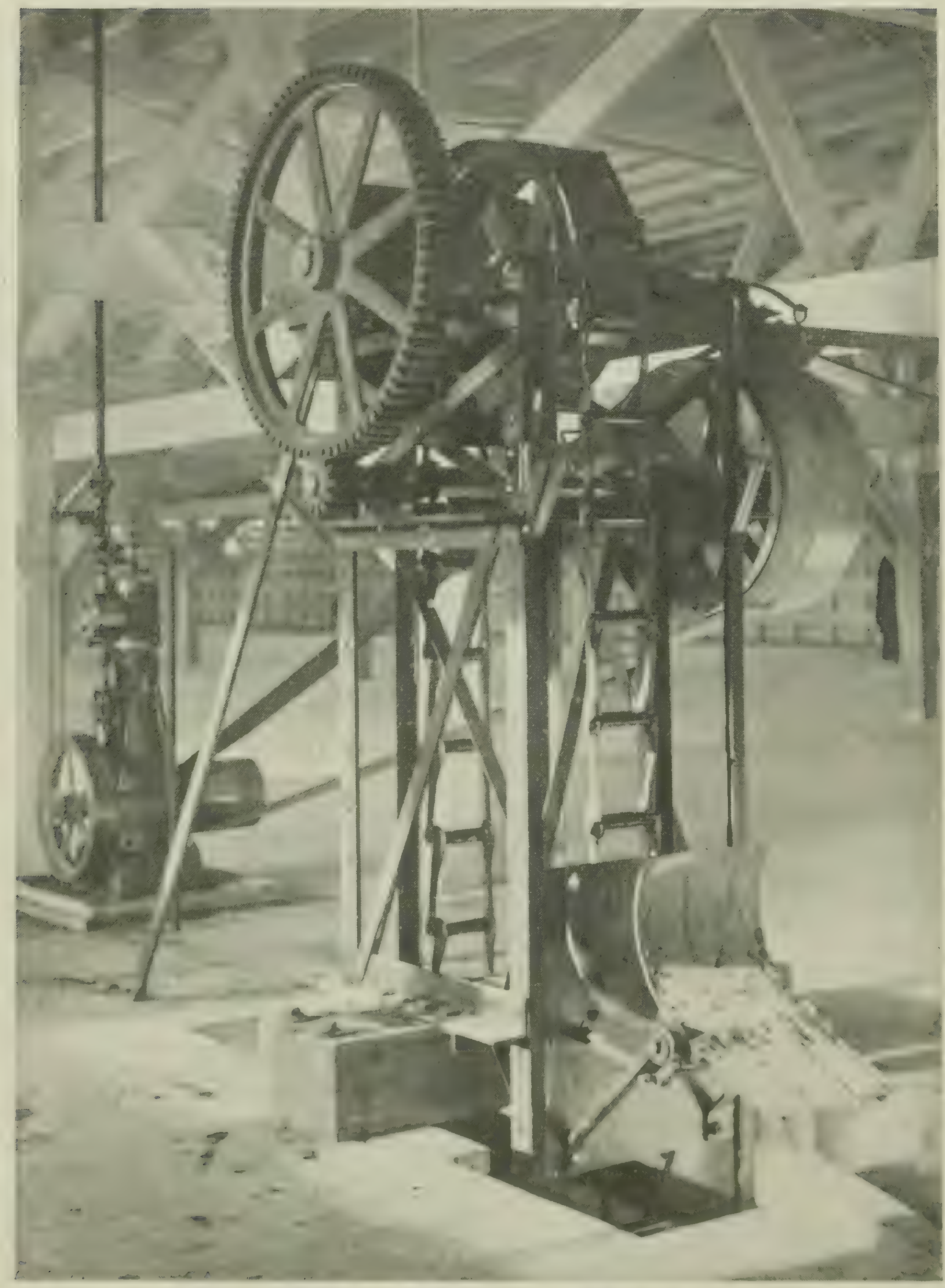
Handling of package freight, as already suggested, is almost of necessity a more expensive operation; but much has been done here also in the effective designing and installation of labor-saving machinery. Such are the "ramps," or traveling-platform conveyors, provided with suitable devices for raising or lowering them to suit the changes in tide or the height of a vessel's freeboard, onto which the package may be delivered or the trucks wheeled and the whole quickly carried to the desired discharging point. Plants of this character have been installed by the Link-Belt Engineering Co. at Boston, Chicago and New Orleans, and six will shortly be in operation at the Buffalo, N. Y., terminus of the Northern Steamship Co. On page 212 is shown an automatic lift for barrels or sacks, erected by the Link-Belt company on the Erie Railroad double-decked pier on the Hudson river. The carriers are driven by a single-strand chain, and a trip tilts them automatically and discharges the barrels or sacks with accuracy either on the upper deck, when elevating, or on the main deck, when lowering—the latter service being effected by reversing the motion of the chain.



THE HOISTING ENGINE FOR THE INSTALLATION OF THE DANISH COAL CO.



COAL-HANDLING PLANT AT NEWTOWN CREEK, BROOKLYN, N. Y.



AUTOMATIC HOIST FOR BARRELS OR SACKS, ERIE R. R. PIER, HUDSON RIVER.

While the development of wharves, separately, by a city, is not conducive to the best results, there are certain provisions on a grand scale, which also are necessary for the purpose, that can be properly done only by the port collectively. Among these the extension of railroad tracks from all the lines entering the port to a connection with all the wharves is of paramount importance. When such connections have been attempted by the railroads themselves in certain cities, they have been frustrated by the authorities or effectually opposed by the people. The effect in such cases has been to drive commerce away to other places, or else to lay a heavy burden upon it in excessive cost of loading and unloading. In New York harbor the introduction of the car-float has rendered it possible to bring the cars to some of the wharves by water, but, as a rule, wharves so served are those belonging to the railroad companies, and there is no general system of rail-connections, although a limited portion of the North river front is traversed by steam tracks of a railroad company. The board of consulting engineers of the commissioners of docks recently has recommended a public extension of railroad tracks along the wharves from a landing-place to be reached by car-floats; it is proposed to connect the tracks with the piers by spurs, and also with warehouses and other establishments.

Such an arrangement, under proper regulation, could not fail to be advantageous to the port, as well as to individual shippers. It is astounding that in the United States, wherein the railroad has had its highest development and most extensive application, the greatest seaport should be destitute of so obvious a necessity as the simple extension of the tracks to the wharves, for the common good. Logic alone would call for it, even were not the European ports full of convincing examples.

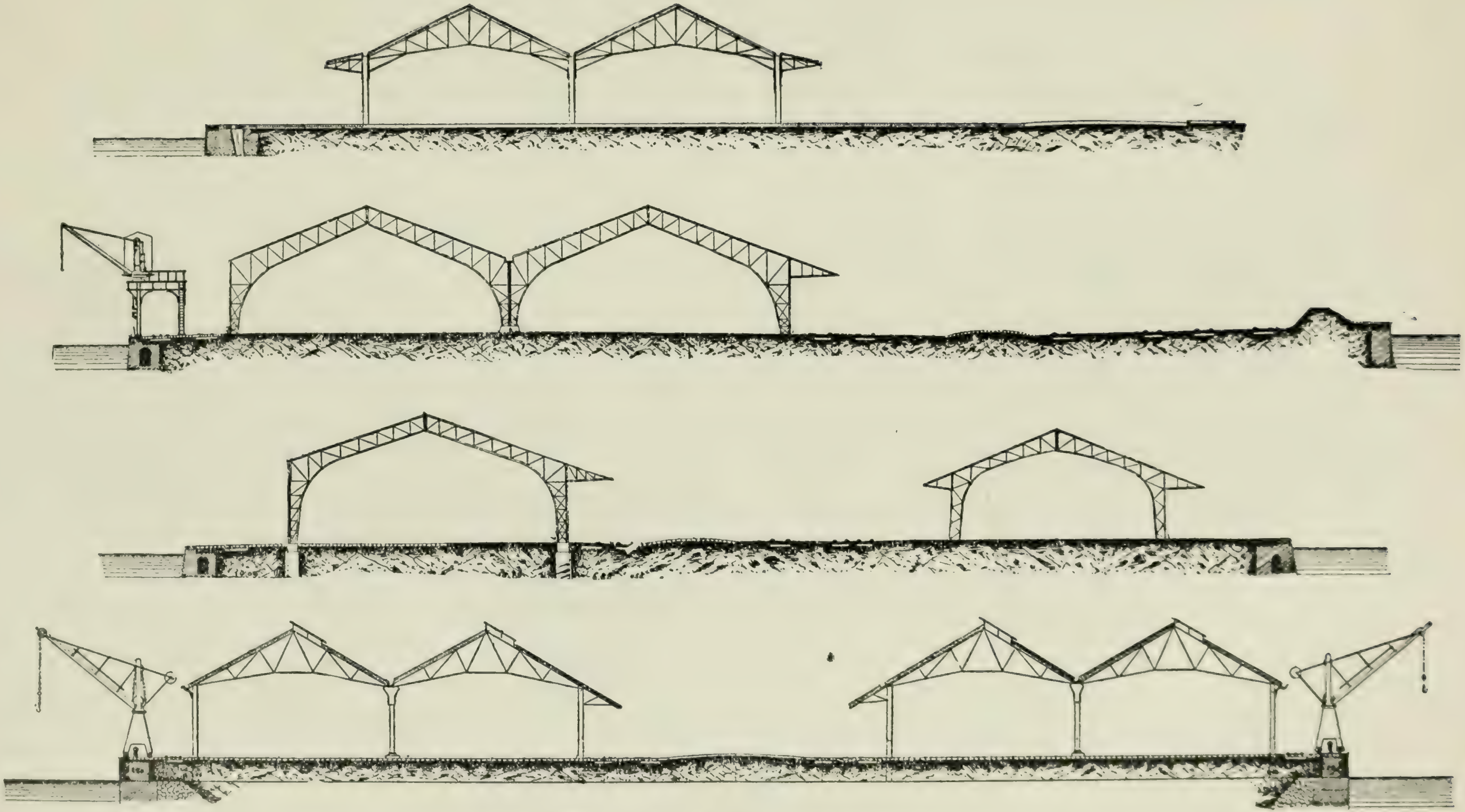
For an interesting instance we may turn again to Glasgow; there the problem of a universal rail-connection has been well solved, and in such a way, too, that the most advantageous portion of the river for a public park, extending for more than a mile, has been left for the beautiful Glasgow Green. The rail system is such that every dock and quay is connected with the entire kingdom, and in communication with the splendid outfit of steam and hydraulic cranes already described. Another interesting example of rail-connections to docks is at Marseilles, page 221; the most extensive of all, perhaps, is that at Hamburg, page 220.

In the United States developments of this sort are usually made, if at all, by private corporations; there is doubtless no reason why a terminal company, properly organized and controlled, could not give adequate service, but the prejudice against this particular form of the use of public streets, illogical though it may be, is so strong that the city will probably have to assume the matter entirely.

There is no denying the fact that the use of marginal streets for railway tracks on the surface seriously interferes with the present uses by wagons and trucks and pedestrians; on that account the elevation of the tracks naturally suggests itself, especially in situations where contiguous streets are likewise affected ; but, the expense ot elevating the entire system of tracks and warehouses being very great, and the inconvenience arising therefrom being considerable, it will usually be found better to keep the rail traffic on *terra firma*, and elevate the rest, excluding all but that which pertains to the wharves. It is ridiculous to make a thoroughfare of a quay, yet that is what is usually done. To remedy present conditions, and depart from long-established usage, requires radical treatment of a very broad nature, which the city alone can well undertake. To quote from Mr. Black's article on " New York's Commercial Blight," published in this magazine several years ago : " It is hard to say who conceived the idea of an exterior street. If he was an engineer, he should have been hanged ; probably he was a truckman."

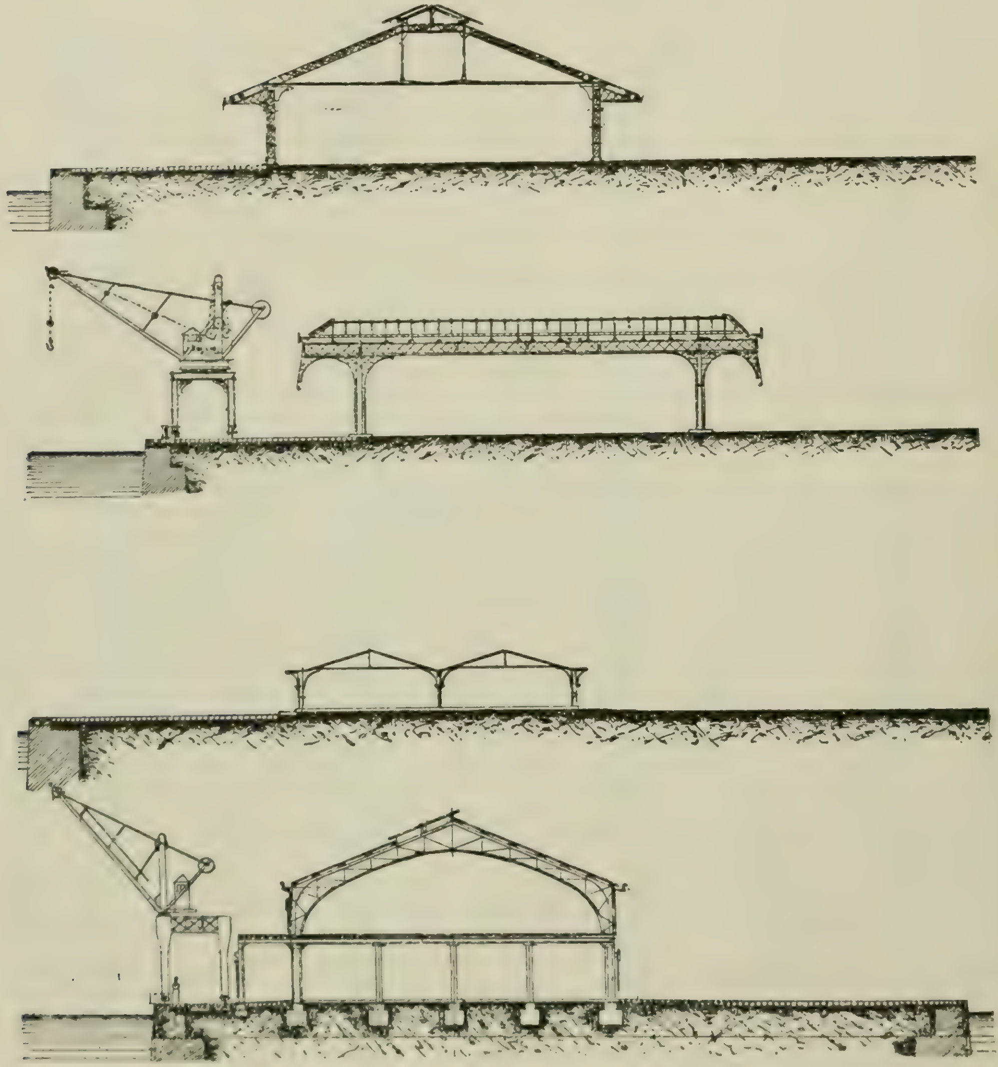
It seems, moreover, as if that truckman was responsible for a good deal else that is inconvenient and costly and absurd in connection with handling goods in transit in New York city. If we were to take a case of foreign goods, in almost any line of business, and follow it, we should find that, after being landed, it is put upon a truck and carted a long distance, either to a bonded warehouse or to the importer's store, where it is re-marked, re-invoiced in United States measures, and carted slowly a long distance back again to railroad or steamer. A very large part of the enormous street traffic which congests down-town New York is composed of conflicting lines of heavily-laden vehicles engaged in this ridiculous occupation of giving the goods two costly journeys which would be utterly needless were warehouses provided at the wharves. Much, if not most, of the goods in transit do not even need warehouses as business is conducted, properly-built sheds on the wharves being more convenient as well as entirely adequate. But much more wharf-space would be needed than is at present provided ; not more room for vessels, but greater width and space for the wharves themselves. Here again Americans are wofully behind the times. The subject is so simple that it is hardly necessary to describe in detail what is done elsewhere, but the illustrations of the types of sheds in use in Germany and France are worthyof study.

The question of the proper proportion of berths and wharves, and of their respective widths, is an intricate one, involving many considerations and far too many figures to be gone into very fully here. Given a certain length of shore line, the question first to be determined is how many separate wharves will best develop its capacity. The number depends somewhat upon the special branches of commerce to be provided for, but chiefly upon the space needed for sheds and the provision of loading—and unloading—appliances and track-systems for moving the goods. These provisions are so costly to in-



FRENCH EXAMPLES OF QUAY SHEDS.

The top cut is a section through the quay at Calais, the second and third at Havre, and the lowest, at Marseilles.



EXAMPLES OF FRENCH QUAY SHEDS.

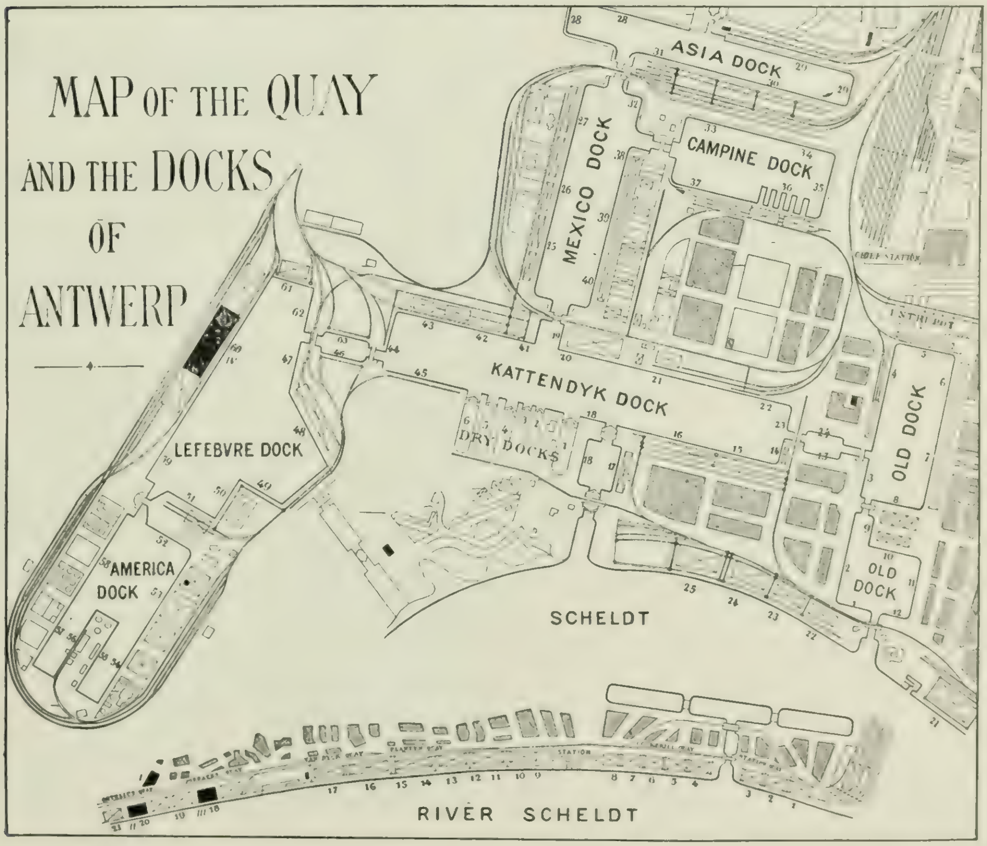
The top section is at Dieppe, the second at Rouen, the third at Bordeaux and the lowest at Marseilles.

stall that it is desirable to have the same plant serve as much quay-front as possible, and, in order to avoid unnecessary duplication, the grouping of wharves about basins becomes a natural development. But the basins take up much room laterally as well as lengthwise, and, where there is a marginal street, such development is impracticable, excepting by pushing the pier line farther and farther out into the water-space, to the disadvantage of the harbor. Here we have another objection to the marginal street system.

If each wharf shall be so adequately provided with cargo-handling devices and with ample storage sheds and railroad track facilities that the maximum mechanical limit of speed in loading and unloading can be attained, vessels will need to remain only the minimum time at the wharf. But this assumption carries with it another,—*viz.*, that there shall also be repair docks, placed so that the vessel need not lie at the commercial wharf while refitting.

One of the finest examples of a concentrated dock system is at Antwerp, the chief port of Belgium and the second of the continent. As is well known, this is not a seaport in the strictest sense of the word, being on the river Scheldt, sixty miles from its mouth; but the entire river is so deep and well lighted that the port can be approached at all hours, and vessels of the largest size and drawing twenty-six feet of water can come up at night. In the daytime vessels of any draught can come up at high water. The quays allow vessels with twenty-six feet draught to moor alongside, there being everywhere sufficient water at low tide; they have a total present length of 3,500 meters (2.17 miles), and are being extended for a further length of 2,000 meters; they have a breadth of 100 meters (328 feet), with movable hydraulic cranes on railroad tracks for discharging and loading the ships.

Sheds 150 feet in width are built along the quays and four railroad tracks extend alongside, upon which the goods are conveyed to and from the railway station. There are eight docks also with railroad



CELEBRATION IN HONOR OF THE OPENING OF THE ANTWERP DOCKS.

tracks passing around them, in communication with the trunk lines, while spacious sheds are disposed along the dock-fronts. Moving on rails around the docks, all of which communicate with one another, are hydraulic cranes, each of 1½ tons, besides one fixed crane of 120 tons, two of 40 tons, one of 20 tons, and one of 10 tons; in the Asia Dock spacious railway quays are provided to discharge steamers loaded with ore, and in the same dock another quay is adapted for loading coal by hydraulic cranes; in the Kattendyk Dock are six splendid dry-docks, one of them being capable of receiving steamers 475 feet in length. The sheds on the quays are placed at the disposal of the commerce, free of any charge during five days before the arrival of the ship and during the loading, after which time a charge is made, graduated for successive periods of time. Ten tugs belonging to the town are continually under steam in the docks, from 6 A. M. till 7 P. M. for moving ships, at an expense of 60 francs ($12 or 50s), and for towing ships up to 1700 tons from one end of the docks to the other. In 1896 the total tonnage movement of the port of Antwerp was 5,280,669 tons, carried in 4.136 steamers and 532 sailing vessels; the tonnage movement of New York, with its 50 miles of quayage, for the same year was 13,464,398 tons, in 5494 steamers and 2949 sailing vessels.* That is to say, in New York two-and-one-half times the tonnage presumably needed ten times the quayage of Antwerp; 01, to put it somewhat more concisely, the relative efficiencies of the Antwerp and New York systems are as 4 to 1.

Another very interesting development of a concentrated dock system is at Hamburg, also a river port, where the narrow width of the Elbe has called for a special disposition of the dock entrances. The map on page 220 gives the general features of the Hamburg layout, whose splendid outfit of quay cranes has already been described and illustrated. The examples of French developments given in the illustrations are all of seaports, and each has evolved in harmony with its topography and available space.

Perhaps the most notable of all the harbor enterprises in the world, and to the engineer one of the most interesting, is that which has made of Glasgow, situated far inland on a narrow, crooked, and at one time unnavigable stream, one of the chief ports of Great Britain,—a work which has extended through more than three centuries. Mr. Deas, the chief engineer of the Clyde Navigation, under whose skilful direction much of the modern part of this great task has been performed, has written a very valuable paper on this great engineering accomplishment,† from which the brief description here

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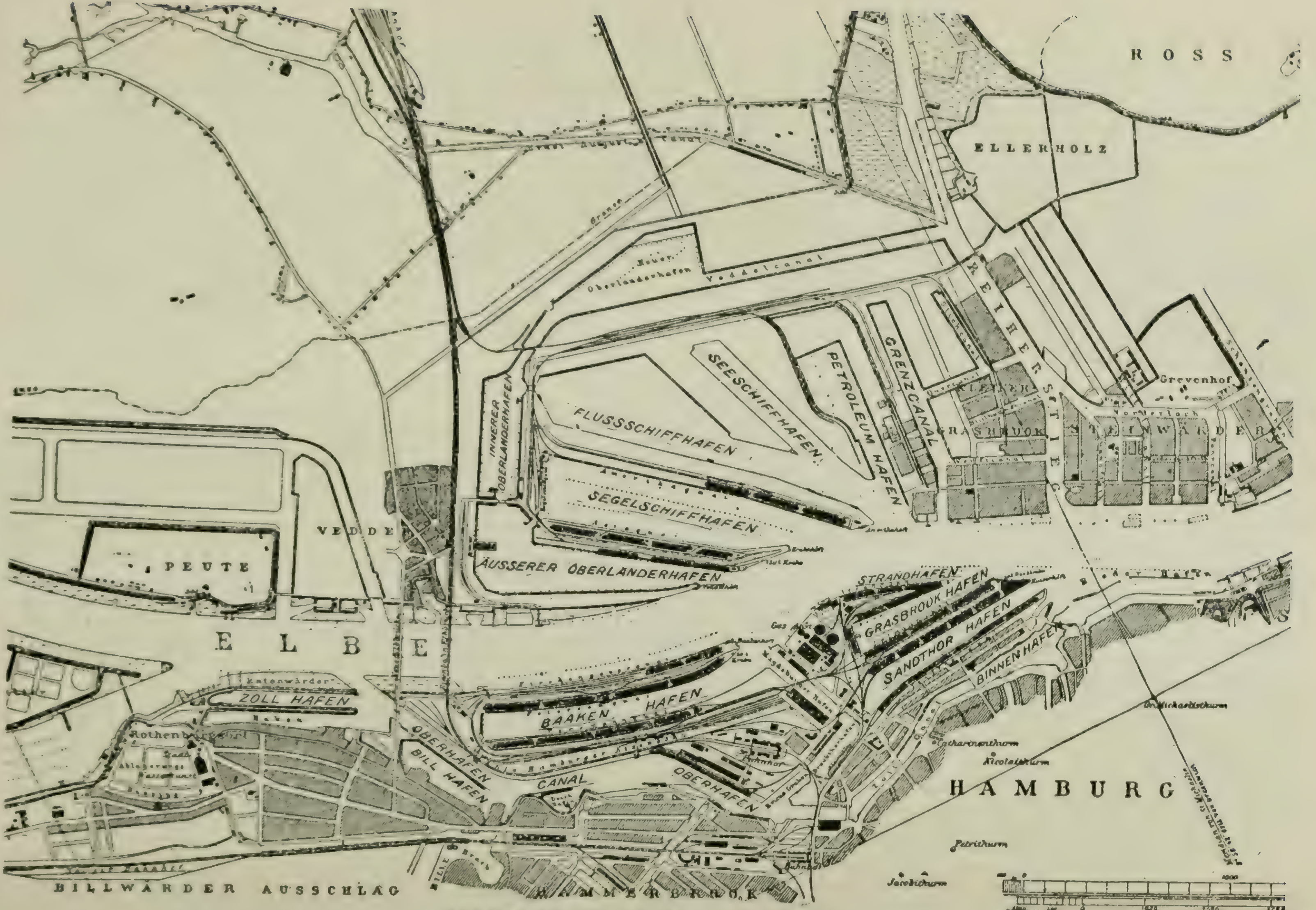
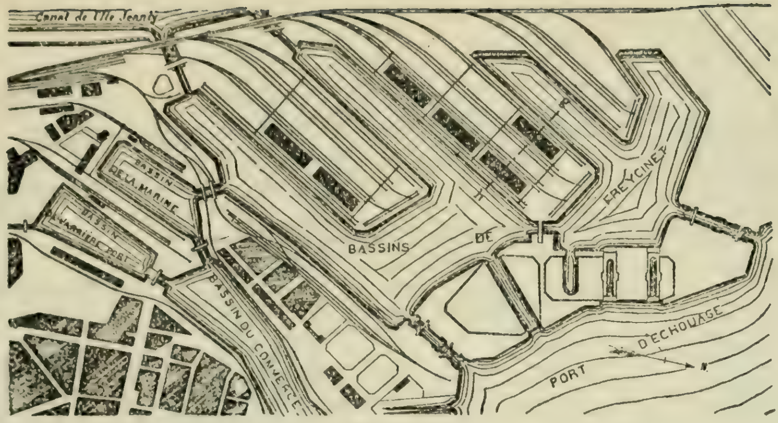
*Annual Report of New York Chamber of Commerce, 1896-97.

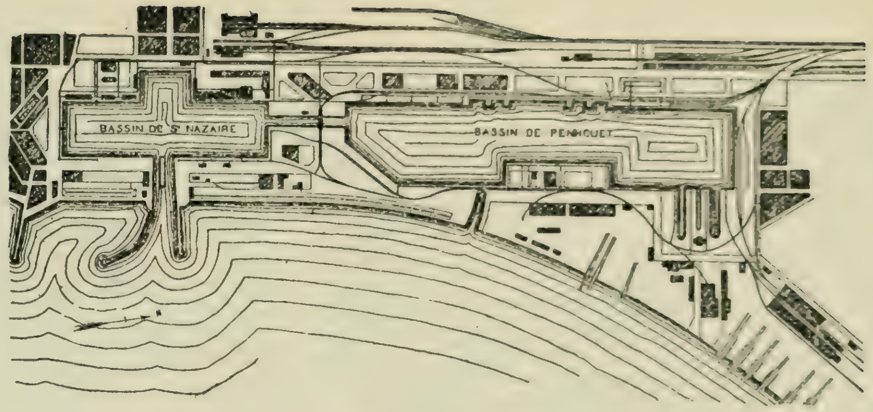
†Trans. Am. Soc. C. E., Vol. XXIX.



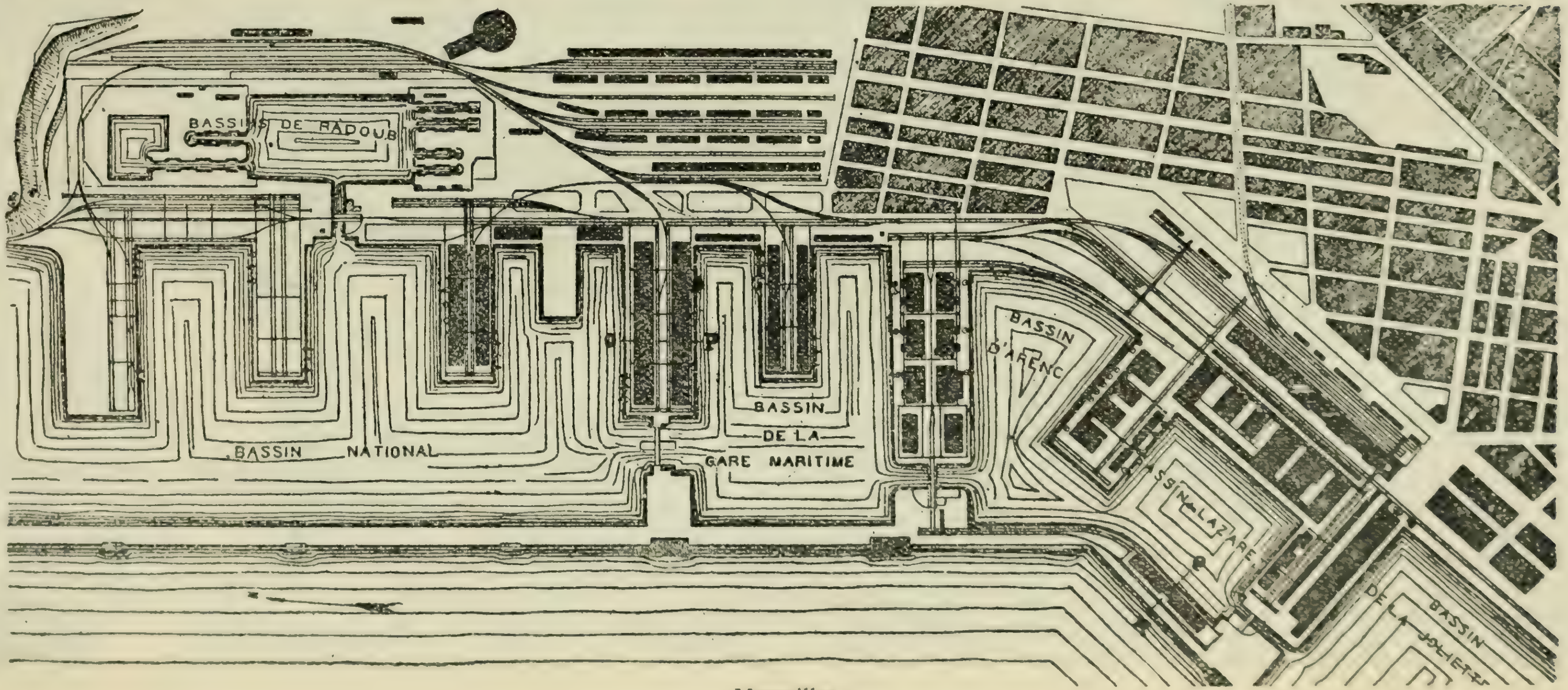
MAP OF A PORTION OF HAMBURG HARBOR.



Dunkerque.

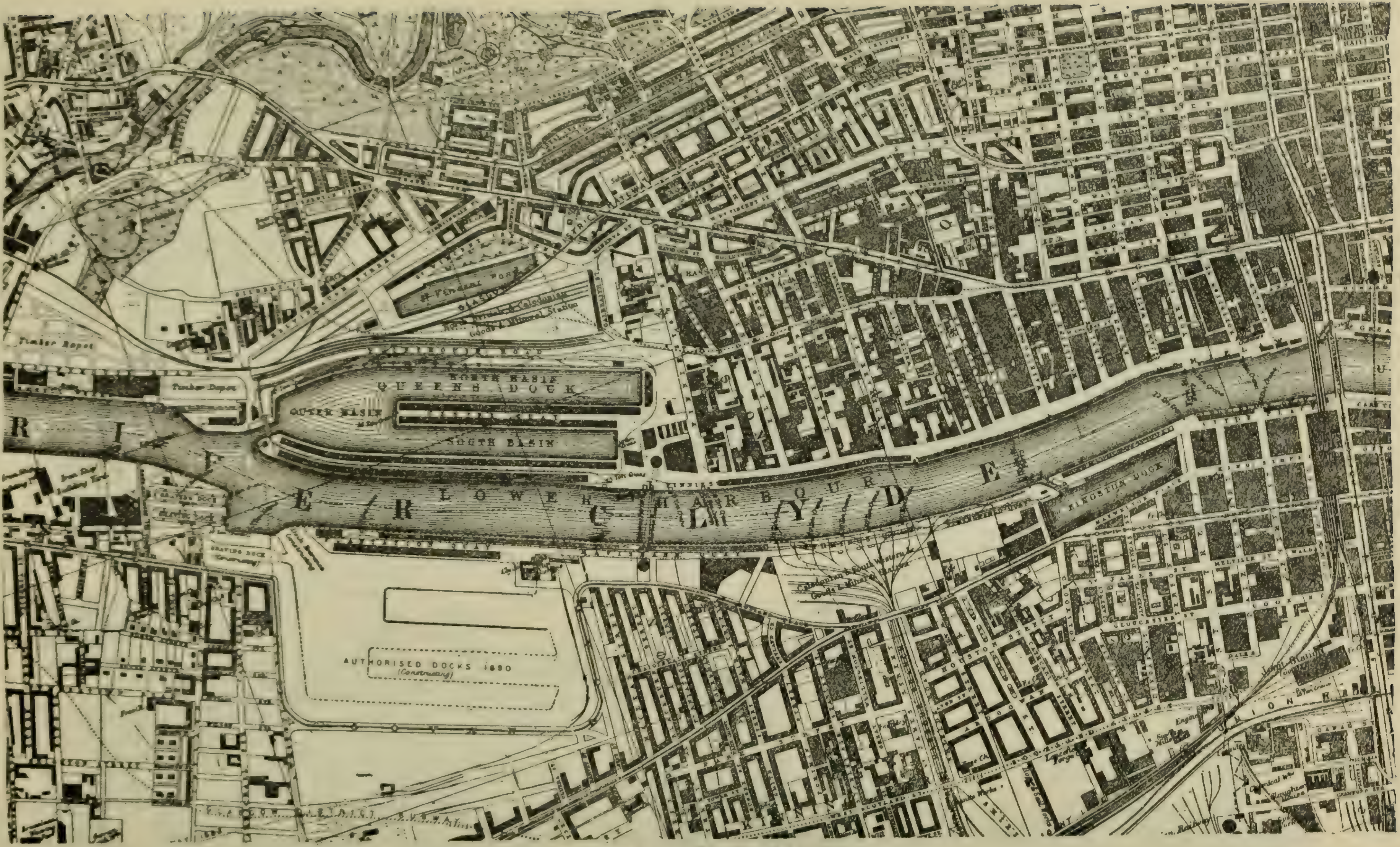


St. Nazaire.



Marseilles.

EXAMPLES OF FRENCH DOCK SYSTEMS.

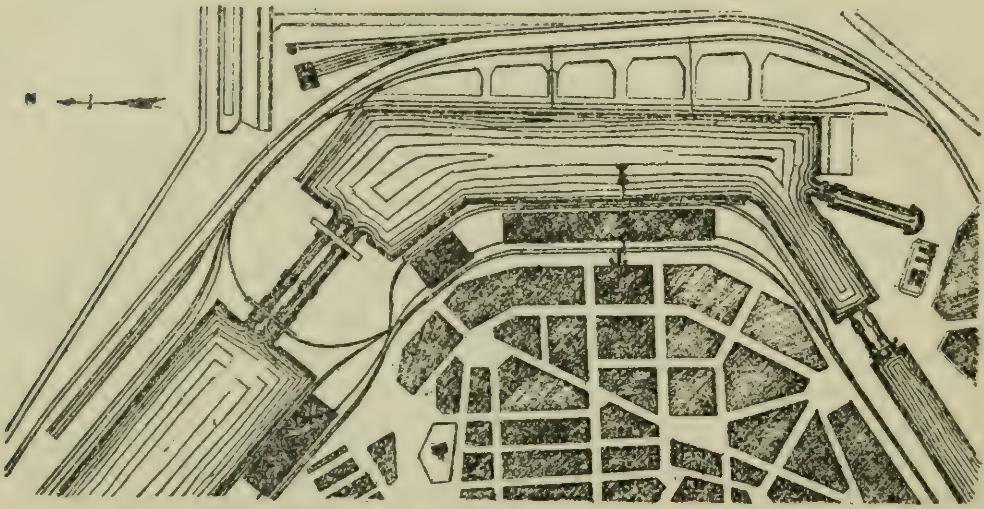


THE LOWER HARBOR OF GLASGOW.

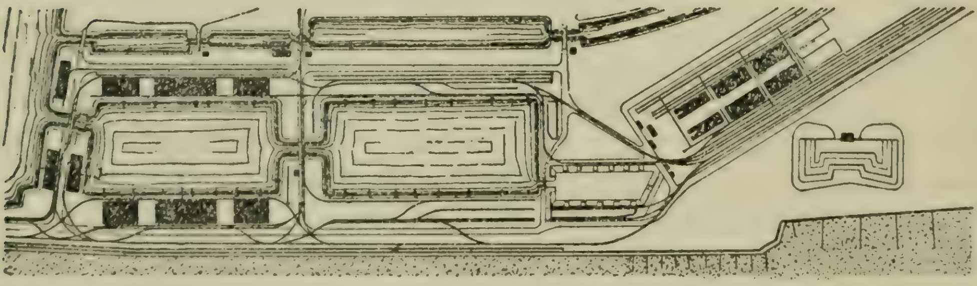
given is culled. One of the most striking illustrations of what has been done is that, whereas formerly there was so little water in the Clyde that merchandise had to be conveyed on pack-horses 29½ miles by land to its usual port, the Campania and the Lucania, each 620 feet long, by 65 feet 3 inches beam, by 43 feet deep, were launched within half a mile of the western boundary of Glasgow, and steamed through the artificial river to the sea.

It is interesting, in passing, to note that the improvement of the river Clyde began in 1566 with attempts to cut channels through sand banks, etc., but that "up to 1768 the entire length of river between Glasgow and the sea remained practically in a state of nature, with only about fifteen inches depth in places at low water and three feet eight inches at high water, choked up with sand banks, impeded by numerous fords, and only suitable for herring boats." By the year 1825, however, the river had been deepened to nine feet at high water, and authority was then granted to increase the depth to thirteen feet. But it was not until 1838 that comprehensive treatment of the river as a whole was begun. Now the depth of the river and harbor is from twenty-seven to twenty-nine feet at high-water neaps, spring tides being two feet higher. Steamers drawing 24½ feet now pass up and down the river. As the river navigation was improved, the harbor was extended, and, when the era of steam navigation arrived, other harbors began to be established all along the Clyde, such as Renfrew, Paisley, Bowling Harbor, Dumbarton, and Port Glasgow. The artificial Clyde extends down to Greenock. Within the Clyde district there are upwards of forty ship-building yards, some of which are several miles above Glasgow. Our map shows the part of the city where the commercial docks are situated and their respective locations and prominent features. The dock first constructed is called Kingston Dock; it has 5½ acres of water-space and about half a mile of quayage; the second is the Queen's Dock, with 33½ acres and nearly two miles of quayage; and the third is now constructing on the south side of the Clyde. The Queen's Dock comprises three basins; the inner basin is 1,866 feet long by 270 wide; then comes a quay 195 feet wide, serving both it and the middle basin, which is 1,647 feet long by 230 feet wide; the outer basin is 1,000 feet by 695 feet. The dock is tidal, and is approached by an entrance 100 feet wide, crossed by a swing bridge. The substructure of the quays is of triple groups of concrete cylinders, and the superstructure of concrete rubble faced with concrete ashlar and surmounted by a granite coping, the old wooden types having been abandoned.

The provisions made by the Clyde trustees in the way of com-



Calais.



Havre.

EXAMPLES OF FRENCH DOCK SYSTEMS.

mercial plant on the docks and quays was described in the previous paper.

The entire cost of the Clyde Navigation to date has been in the neighborhood of $70,000,000, and there has been returned a gross revenue of not far from $50,000,000, the annual revenue now amounting to nearly $2,000,000, or something less than three per cent. The surplus revenue, after meeting all expenses and fixed charges, is now about $200,000 (£40,000) annually.

The illustrations of French dock systems and quay sheds and the map of Hamburg harbor are reproduced from the Transactions of the American Society of Civil Engineers. The author desires also to express his acknowledgments to Mr. C. W. Hunt and the Brown Hoisting and Conveying Machine Co. for courteous assistance.

COST-KEEPING METHODS IN MACHINE-SHOP AND FOUNDRY.

By Henry Roland.

II.—DETAILS OF PRACTICE IN WIDELY-KNOWN SHOPS.

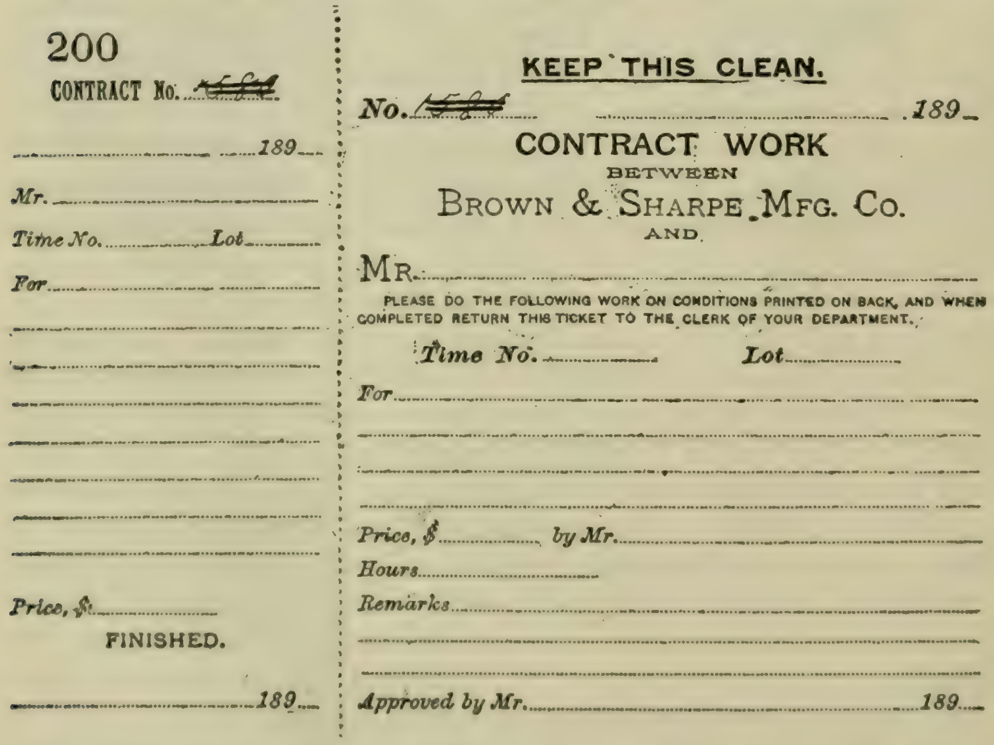
NO abstract statement, even though supported by the most cogent evidence and argument, can ever have the force of example. Therefore details of practice must be held more instructive than any comment or deduction based upon or drawn from the actuality, and in this view the close details, which here follow, of the means actually used in a number of important establishments to reduce labor-cost are of the utmost value.

The Midvale, Sellers, and Baldwin establishments, of Philadelphia, Pa., and the Builders' Iron Foundry, of Providence, R. I., declare in favor of fixed piece-rates. Brown & Sharpe, of Providence, Yale & Towne, of Stamford, Conn., the Pond Machine Tool Works, of Plainfield, N.J., and many others believe in continued "adjustments," "adjustment" meaning reduction almost invariably. In the Baldwin shops piece-rates are not changed except in case of improved facilities which lower the time required for production, and the same is true at the Midvale and Sellers shops. There are piece-rates now in force at the Baldwin which have not been changed for twenty years. The Yale & Towne piece-rates are changed, or "revised," yearly, the revision of each department falling on a different date from that in any other department, revision almost invariably meaning reduction as before said; and this yearly reduction is accepted by the hands without resistance.

Before entering upon the details of individual shop practice, it may be said that inspection is rigid in all of the establishments here mentioned, although their high and, in many instances, world-wide reputation renders such a statement almost superfluous, and that the quality of work produced is of the highest grade in point of workmanship and reputation among purchasers and users.

In the Brown & Sharpe shops about two-thirds of the work is done at piece-rates. There is a great amount of special work done on individual orders which does not commonly fall under any established piece-rate, and is therefore put through at day-rates. Most of the moulders are paid at piece-rates, although a large amount of special work is constantly going through the foundry, much of which is paid for at day-rates. There is no contracting whatever in the Brown & Sharpe shops, nor can any workman in any way make a profit on the labor of other workmen. The shop routine on piece-work is simple, except in the detail of fixing piece-rates, which is made a matter of consultation ; sometimes the workman is called into the discussion.

It is the policy of the Brown & Sharpe establishment to trust in a multitude of counsellors, all experts, and all, strange as it may seem, open to conviction by the arguments or experience of others. But this extended and elaborate consideration of a piece-rate is not held to infallibly produce a correct result. Instances have been known in this shop where a workman voluntarily reduced a piece-rate, saying it was too high. Where a workman, after trial, thinks a piece-rate too low, the matter is fully considered once more, often with the result of increasing the rate. Sometimes, however, the increase is refused. When a piece-rate is fixed, the job goes to the workman with this blank, from a stub-book, and the workman may be any hand in the shops, from a boy at 4 cents per hour to the highest-priced mechanic.



200

CONTRACT No. [illegible]

.... 189..

Mr. ....

Time No. .... *Lot* ....

For ....

Price, $ ....

FINISHED.

.... 189..

KEEP THIS CLEAN.

No. [illegible] .... 189..

CONTRACT WORK

BETWEEN

BROWN & SHARPE MFG. CO.

AND

MR. ....

PLEASE DO THE FOLLOWING WORK ON CONDITIONS PRINTED ON BACK, AND WHEN COMPLETED RETURN THIS TICKET TO THE CLERK OF YOUR DEPARTMENT.

Time No. .... *Lot* ....

For ....

Price, $ .... *by Mr.* ....

Hours ....

Remarks ....

Approved by Mr. .... 189..

This contract bears on its back the words :

The person accepting this contract for piece-work agrees to complete the work specified to the satisfaction of the inspector, and for the amount named in the contract.

Only such work as passes inspection will be paid for, and the workman will be charged for lost labor on parts spoiled while he holds this contract, unless occurring from a cause for which he was not responsible.

This contract must be carefully preserved and returned with the foreman's signature and exact time recorded.

This contract is returned to the foreman with the finished work, and name and number of pieces and time and rate of workman's earnings are entered in a suitably-ruled book supplied to each foreman for the purpose. These record books are of the utmost value for reference, giving a brief history of all piece-work done in the shop.

Spoiled work is arbitrated, and, if the workman is clearly in fault, he stands the loss of his labor, the shop losing the stock: if the piece-worker spoils a second operation, he does not pay for the previous work.

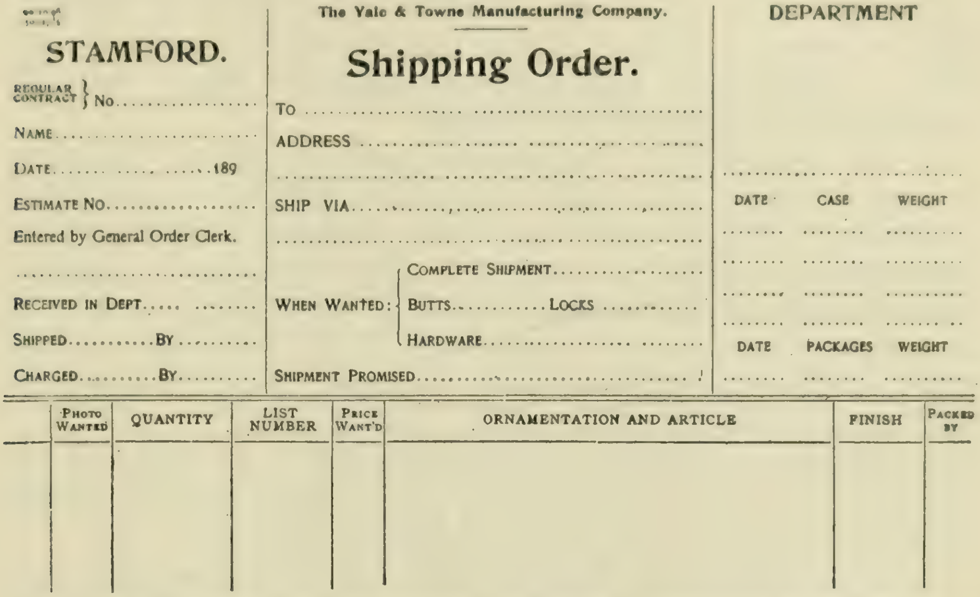
A piece-rate may be increased before the first job is finished, either because the rate was fixed too low, or because of hard stock or unexpected difficulties in some of the operations.

There is no hard and fast rule in the Brown & Sharpe shops as to the hour-rate a piece-worker may earn before it is considered advisable to reduce the piece-rate. If the work is uniformly well done, a workman may hold a high rate for a long time. But the general rule is that, as the workman continues on one piece, his out-put increases, and, when it becomes certain in the minds of his superiors that his piece-rate can be lowered without impairing his ability to earn good wages, the adjustment is made, with a full exhibit of the situation to the workman, who is expected to, and almost invariably does, take a reasonable view of the matter, everything being done deliberately and under consultation. Here, it will be noticed, the implied condition of the "going day-rate" of workmen's wage becomes the real ground of the argument justifying the piece-price reduction. The workman is making much more than the "going rate" of his class,—that is to say, more than he is entitled to earn,—and has been making this unwarranted rate for a long time by grace of the employer in fixing a high piece-rate. He is offered a lower piece-rate, which will still enable him to make more than the going day-rate. If he refuses the cut, he is shown that he is acting against his own interest, and the ground is taken that he is ungrateful to a benefactor. How just these assumptions are, or how unjust, is a matter of no importance, as before stated. The workman can take his choice of two losses, and he is almost certain to choose the lesser of the two, and continue his piece-work at the reduced rate offered, as it gives him higher pay than he is likely to obtain otherwise, while the shop is perfectly justified in the reduction, which still leaves the pay higher than the workman can obtain elsewhere.

The Yale & Towne Manufacturing Company, Stamford, Conn., with its high pay-roll of 1,100 names, is too well known as a producer of high-class locks and builders' hardware to need extended notice here. The establishment is divided into a considerable number of departments, each having its own foreman and book-keeper; and, when the shop is full, about four-fifths of its work is done at piece-rates. In all cases slack work increases the percentage of day-rate work, because the jobs do not last as long and there is more special work in dull times. The tool-makers,—of whom there is a large force, as tool-making is carried to the extreme limits of economy in this shop,—pattern-makers, chasers, and modelers are all day-pay men, and all small jobs of special work are done at day-pay.

The Yale & Towne piece-rates are fixed much as in the Brown & Sharpe shops, under consultation with those supposed to be best informed, and, when a piece-rate is fixed, it is expected to remain in force for a year, except in case of new work, where the management assumes the possibility of error in rate-fixing, and reserves the right to make changes at any time during the first twelve months. Such changes may be in either direction—up or down. For fixing upon the yearly "adjustment" of old rates, the results of the previous twelve months are tabulated and compared with foregoing records; and the rate is discussed with the foreman of the department where it is to be used, and with experts in the line of work. The new rate thus established is sometimes greater than that for the year just passed, although, as a rule, the new rate is lower than the old one. Whatever the rate may be, it is commonly accepted without protest by the workmen. If protest is made, the workman is requested to make a trial under it, and the trial almost invariably establishes the correctness of the rate. Thus in one case a trial under protest resulted in a first day's work at a loss to the workman, the second day was about even, while the third gave a bonus above going day-rates to the piece-worker, who finally averaged twenty per cent. above his day-rate for the year's work. In some rare cases, however, the piece-rate is raised after a thorough trial. Resort is sometimes had in the Yale & Towne piece-rate fixing to actual trial, the work being given to an extremely good workman, whose trial output is assumed to be about twenty per cent. too low, as it is invariably exceeded by about that difference by the piece-worker operating under the piece-rate.

The shop routine of piece-work at the Yale & Towne begins with the receipt of the shipping order, which is first audited in the main office of the works, and, if satisfactory, then passes to the superintendent of the department producing the work demanded, who first audits the bill himself; if he finds it acceptable and in proper form, he returns it to the order clerks, who record it and fill it as far as possible from finished stores; if the order can be completely checked from items in stock, the goods are shipped the same day; if not, the order goes back from the finished stores to the order clerks again, who proceed to fill out "requisitions" to departments for the lacking items; the order is then returned to the shipping-room, and held until filled. This shipping order is as follows:



STAMFORD.

REGULAR / CONTRACT No. ....

NAME ....

DATE 189

ESTIMATE NO. ....

Entered by General Order Clerk.

....

RECEIVED IN DEPT. ....

SHIPPED .... BY ....

CHARGED .... BY ....

The Yale & Towne Manufacturing Company.

Shipping Order.

TO ....

ADDRESS ....

....

SHIP VIA ....

....

WHEN WANTED: COMPLETE SHIPMENT ....

BUTTS .... LOCKS ....

HARDWARE ....

SHIPMENT PROMISED ....

DEPARTMENT

....

DATE	CASE	WEIGHT
....	....	....
....	....	....
....	....	....
....	....	....
DATE	PACKAGES	WEIGHT
....	....	....

	PHOTO WANTED	QUANTITY	LIST NUMBER	PRICE WANT'D	ORNAMENTATION AND ARTICLE	FINISH	PACKED BY

The department "requisitions" furnish the order to proceed with department operations. If rough stores are at hand, the finishing-time required is estimated, and the date of completion is given to the order clerks as the "due-date," or date on which the finished work will reach the shipping-room. If castings are wanted, the head foundryman makes a promise for delivery to the finishing department, or, if patterns must be made, the foreman of the pattern-makers promises the patterns at a certain date, the foundryman promises the castings, and the head of the department requisitioned adds his finishing-time, and thus fixes on the due-date and transmits the same to the order clerks, who forward the due-date to the customer. This due-date must be kept good, and is not to be regarded merely as a guess. The goods are expected to be in the shipping-room on the date named, and any failure causes conversation of an unpleasant nature to the foreman responsible. If any part of an order is to be filled from the outside, the first "requisitioned" foreman in turn issues a requisition on the purchasing agent, and the purchasing agent's advices may have to be awaited before deciding upon the due-date. The requisition from the order clerks to the department goes finally to the shipping-room with the finished work, and the requisition is filled in with all particulars of labor- and stock-cost, which are afterward collected in reference-books for future guidance.

While individual piece-rates are the rule in the Yale & Towne shops, there are yet some contracts in force under which contractors employ workmen and can make money from the work of others, and it was said that in one large department, where the work has been reduced fifty per cent. in labor-cost under the individual piece-rate system, the old contractor, who is still an employee of the concern, offers to take the work on contract at ten per cent. below present rates, as methods and tools have been improved largely under his charge since his contract was abolished.

As in the Brown & Sharpe shops, so in the Yale & Towne the workmen are in direct communication with the management, although nominally under exclusive control of their foremen ; all sources of dissatisfaction are carefully investigated, and every effort is made to reach impartial conclusions agreeable to all concerned, an amount of consideration being given to the feelings of the individual workman which would not be entertained for a moment in the ordinary large machine-shop operated on the day-pay system.

At the De La Val shops, Poughkeepsie, N. Y., all orders are received from the New York office, the shop being treated as a trusted employee of the New York office with a yearly settlement.

The shop routine for handling work begins with an order from the New York office order book, each leaf of which is printed in three sections, first a stub, retained in the book, then a perforated cross line and the original order filled at the New York office and manifolded on the reverse side of the third section of the leaf, there being a second cross-line of perforations in the order book page, so that the manifold order blank can be turned under the original order blank, permitting the insertion of a carbon paper between the two, and the filling of both orders at once, all as shown in the reproduction below:

(Stub retained in N. Y. Office Order Book.)

No.... 189
To be shipped....... ....
....
....
By......................
Via......................
....
....
Ordered by....... ....

(Original Order made by N. Y. Office; a duplicate-carbon copy is sent to the Poughkeepsie shop.)

(POUGHKEEPSIE WORKS.)

No....... NEW YORK,............189
Ship.......................
To......................................
....
By.................... Via...................
....
....
....
Shipped
....

By use of this ingeniously-devised order book the New York office has a stub duplicate of each shop order transmitted, and the shop has an original office order and a manifold *fac-simile* duplicate, which it compares with the original order and then returns to the main office, thus certifying the receipt of the order, while the manifold serves as a check on the stub in the New York office order book, so that no misunderstanding of orders between the office and shop is possible.

All material received from the outside goes to the rough stores, and is checked in and out by a system which gives instant information as to stores on hand, while a finished-stores room is placed between the machine-shop and the assembling department, all finished parts being checked in and out, as in the case of rough stores.

The De La Val separator, or milk-and-cream-separating machine, requires from 6,000 to 7,000 revolutions per minute of its effective member,—a spindle carrying a steel bowl,—and necessitates construction of the most accurate description. Much of the work is repairs, and repairs are all made at piece-rates, as was the original construction. The shop has been under three managers, and the present control is unfavorable to piece-work, believing that, with the same gages and same inspection, work assembles better when made at day-rates than when made at piece-rates.

A filled-out repair statement is here given, which will be of interest to those dealing with machine repairs on a factory scale.

(POUGHKEEPSIE WORKS.)

No. *557* $\left\{ \begin{matrix} 4204 \\ 4214 \end{matrix} \right\}$ *503.* New York, *3/3/97.*

Ship..............................

To *N. N. Winston,*
Smithfield, Henry Co., Ky.

By *Express* Via *Am. X.*

Repair Baby No. 2 Bowl No. 19,547—your reports 4204 and 4214.

1 No. 509 Bowl Spindle	*2.90*
6 " 600 " Rivets	*.10*
1 " 442 Top Bearing	*1.00*
4 " 507 Milk Tubes	*1.00*
1 " 506 Cream Screw	*.10*
1 " 510 Tubular Shaft	*1.50*
1 " 513 Bottom Disc	*.10*
1 " 512 Intm'd Disc	*.15*
Bowl Re-tinned	*1.00*
18¾ Hours at 40c	*7.50*
	15.45
Expressage in	*.65*
Shipped by	*16.10*

March 16, 1897.
Bowl Re-balanced.

The foreman's report card is made in three parts,—the first belonging to the machine-shop, the second to the paint-shop, and the third to the inspector of finished stores,—and at once places the responsibility for faulty work where it belongs. The size of this card is eight inches by six.

REPORT CARD.

THE DE LA VAL SEPARATOR WORKS.

Shop Order............

No. of Part........ ...

R. M. (Shop.)			(Paint Shop.) F. M.				(Inspector.) F. M.			(Finished Stores.)
Date.	Stock.	Rec'd by	Date.	Good.	Bad.	Rec'd by	Date.	Good.	Bad.	Rec'd by
.....	....	....	.....	.....	....	....	.....	.....	....	....
.....	....	....	.....	.....	....	....	.....	.....	....	....
.....	....	....	.....	... .	....	....	.....	.....	....	....

Work goes through the shop on an individual workman's card as below:

Shop Order No............ | THE DE LA VAL SEPARATOR WORKS.

No........ Mr...................................

Piece No........ Name.. ...

Operation...

Machine No....... ....

Time.	Hrs.	Min.
....	......	......
....	......	......
....	......	......
....	......	......

Finished.

This card is white for new work, and pink for repair work. The information given by this card is condensed and tabulated for reference in the workman's pay receipt, which is made as given on the filled-out blank herewith.

DATE, *Mar. 29, 1897.* PART No. *501* ORDER No. *4*

WORKMAN'S NAME, *Samuel Melgaard.*

QUANTITY, *80*	RATE, *20*				*16.00*	
Week ending	HOURS.	*Per Hour* RATE.				
April 3.	*59*	*18*	*10*	*62*	....	...
....	....	....	....	....	....	....
....	....	....	...	....	....	....
BAL.	....	....	*5*	*38*	....	...
			16	*00*	*16*	*00*

REC'D PAYMENT, *Samuel Melgaard.*

The size of this card is six inches by seven and a quarter.

This receipt gives the important results of each piece-rate contract in the briefest terms, and is so filed as to permit instant access for two years, which is considered the limit of probable reference time.

In the De La Val shops piece-rates are subject to change without notice, and the workman is not guaranteed a minimum earning. The greater part of the workmen are employed at day-rates. Forty cents per hour is the highest piece-rate-earning permitted.

The methods of inspection do not insure against previous faulty operations on a piece, and there is no penalty for spoiled work, except loss of workman's time. Some of the hands prefer piece-work, some day-work. Twenty cents per hour is paid on piece-work time on regular pay day, should the piece-work run over it, and at the end of a piece-rate contract the workman receives the balance due him, as per card given.

At the Pond Machine Tool Works, Plainfield, N. J., piece-rates are fixed by the official charged with that duty, who may make the estimate unaided, or may, and very often does, advise with others who can give him information, including workmen. In some cases various workmen capable of executing a certain piece of work are asked for their own terms, and the work is given to the one most suitable for the job. There is no face-to-face competition or bidding. Prices are obtained from different workmen, and the award is made where it seems to the best interests of all concerned to place the contract. Some of the work in the foundry is done at piece-rates, by contract with an individual moulder, who may or may not employ others to help him. The foundry foreman is paid a salary, and cannot make anything above his pay. Piece-rates in both the foundry and machine-shop are good for a single job only, and may be varied either way, up or down, for the same job at a subsequent date.

The work at the Pond shops is heavy; large lathes, large planers, boring mills, and radial drillers form the principal part of their machine-tool output, which is the regular work of the shop. Outside work taken in is also large. Heavy gun-carriages for the government and a lot of heavy rock-pulverizing machines were under way on the floor when the Pond shops were visited, and almost all of their work is heavier than that usually done at piece-rates. There is, however, no weight-limit for piece-work. Work at the Midvale Steel Works and at the Builders' Iron Foundry is also heavy, and the Midvale places everything at piece-rates, while the Builders' Iron Foundry intends to operate under piece-rates in all cases where the quantity of work makes it economical to do so. The Sellers Shops also build work of magnitude, and, although there is a generally-entertained idea that piece-rate methods cannot be successfully applied to finishing heavy work, there is no obvious ground for the belief. In the Midvale and Sellers shops piece-rates not fully determined by previous jobs are made by surface time calculations, and at the Midvale absolute confidence is felt in piece-rates thus determined; I believe the same is true at the Sellers shop. Work at the Pond shops, where as many as 900 hands have been on the pay-roll at one time, is about equally divided between piece-work and day-work. The more ambitious hands endeavor to obtain piece-work, as piece-rates secure the possibility of something more than the day-pay rate.

Two blank forms are used in the piece-work routine of the Pond shops: the first is a stock order on which stock is procured from the stock-room; this order authorizes the delivery of stock to the foreman of a department, who receipts for it, and the order goes from the stock-room to the office, where it is entered to proper accounts.

Form of Pond stock order. Size 7×5½ ins.

No. *80800A.* Mr.................. ....189....
St'k order No.......... The stock herewith is for order No...........
Please receipt for same.

	No.	Wt. or Num.	Price.		
....	....	....	......	......	......
....	....	....	......	......	......

Received on above date

....

The Pond piece-rate contract has a time record printed on its back. The contract form reads as follows:

Face of contract, size 8½ × 5½.

Form 44.

OFFICE OF

THE POND MACHINE TOOL CO. Plainfield, N. J..............189

Piece-work No........... B.............................. No.........

for...

Order or Lot No.	Piece No.	Name of Piece or Part.	Price.		Amount.	

The above work will be settled for when order is completed and signed by the nspector.

Price approved.................

Back of contract: size 8½ × 5½.

Piece-Work No.............. B.............................. No..........

TIME RECORD. Rate, $......

	Hrs.	Amount.			Hrs.	Amount.	

Time on Poor Stock.

	Hrs.	Amount.	

Time on Spoiled Work.

	Hrs.	Amount.	

This contract and time record are printed in duplicate on a perforated sheet, the duplicates going to the office.

The Pond system of handling piece-work is marked by entire freedom from the possibility of establishing what might prove to be embarrassing precedents, the motive being to deal with each individual job on new ground, so that the shop may have no hindrance in the use of knowledge acquired by experience.

Spoiled work entails the loss to the workman of his time only, the shop standing the cost of the material. Work on castings which disclose defects in the course of finishing is paid for at day-rates, the shop losing both the casting and time put on in partial finishing.

At the Baldwin shops, Philadelphia, where as many as 4,000 names have been on the pay-roll at one time, a rate once fixed is permanent, and all of the men, without exception, prefer the piece-rate, being fully convinced that piece-work is better for themselves and better for the shop, and consequently far more satisfactory both ways than the day-rate. A visitor at the Baldwin shops who is familiar with machine-shop interiors is made immediately conscious of the close attention the hands are giving to their work, and, as he becomes acquainted with the various departments of that large establishment, he finds that all the workmen in the place are as eagerly expediting their labors as the first which met his eye. The cause of this diligence and voluntary exertion becomes clear when the observer learns that the man who makes the highest pay is held in highest esteem by the management, and hence has every inducement to turn out all the work he possibly can. By so doing he not only adds to his pay, but ensures the continuance of his large winning, since he increases his good standing by his large production. In addition to this certainty of rates, the Baldwin workman is sure of employment so long as he does not forfeit his good standing by some fault of his own, his long time of good service ensuring his retention when age begins to diminish his powers. The only men discharged are those who cannot be made to bring their pay high enough to meet the views of the management, high pay at fixed piece-rates meaning, of course, the high production rate which the whole policy of the Baldwin shops is designed to secure. The results of this policy can be clearly placed before the reader by the simple statement that the Baldwin establishment is the largest single producer of locomotives in the world, and pays its men higher wages than are paid for similar employment elsewhere.

The establishment of Wm. Sellers & Co., Philadelphia, is one of the most widely known of American machine-shops, and has been a conspicuous factor in the advancement of American machine-shop practice. The high pay-roll for all branches of the business includes about 1,100 names.

Work at these shops is mainly at piece-rates, which are fixed in the office exclusively, either by reference to previous jobs or by surface computation, and, when once established, are not changed.

Spoiled work is arbitrated, but the regulations are directed against carelessness on the part of the workman, who is required to examine all work done on a job before it comes into his hands for a subsequent operation, and to report any imperfection to his foreman. Failing to report previous errors in a piece of work, the last workman loses all the work on a faulty piece, no matter by whom performed.

The shop routine of piece-work begins with the shop order, which is made up so as to finally include a complete history of the job, except labor-costs and time. The face of the shop order is as below.

Form 1. [illegible]

189 ***No. of Order***

Order Book Folio ***Charge***

For

Delivered ***189***

Sig. ***Receiving and Delivering Clerk.*** ***WEIGHTS.***

Boxing Lumber ***feet.*** ***Hauling*** ***loads to*** ***Expense***

Charged ***189***

Sales Book Folio ***Sales Clerk Sig.*** .... ***WM. SELLERS & CO., Incorporated,***

Cost Book Folio ***Cost Clerk Sig.*** .... ***Per***

The back of this order carries a synopsis blank, as follows.

○ ***Received by Foreman.***

○ ***Finished*** ***189*** ***Gang Foreman.***

○ ***Received by Receiving-and Shipping Clerk.***

○ " " ***Sales*** "

○ " " ***Order*** "

○ " " ***Cost*** "

Inspected ***189*** ***Clerk.***

The piece-work ticket, or contract with workmen, is 4 × 3 inches in size, and reads as follows on the face :

Book........ Page........

Ticket No................. Register No............ Order No. ....

To.. Card No................

Charge.. Group No. ....

... . Job......... Cut... ....

....

....

Price................Time..........Shop No. of Machine..........

Upon the conditions on the other side.

..................................Foreman.

The reverse is printed as below :

Conditioned, that in accepting this contract the contractor guarantees to complete the same to the entire satisfaction of the foreman with whom he contracts, and, if he expends any labor upon raw materials, or upon materials partially completed by other parties, which are defective in workmanship or materials, he shall not be paid for the same, unless the defects are pointed out by him and accepted by the foreman in writing.

Return this ticket to your foreman every day on which you charge time to it.

DATE.	TIME		DATE.	TIME.	
	on this Job	Total this day.		on this Job	Total this day.
....	....	....	....	....	....
....	....	....	....	....	....
....	....	....	....	....	....
....	....	....	....	....	....

Accepted by...

Foreman.

The position of the Sellers Management is clearly defined as favoring piece-work wherever it can be used, and against the changing of piece-rates once established, except in case of the employment of improved means of production.

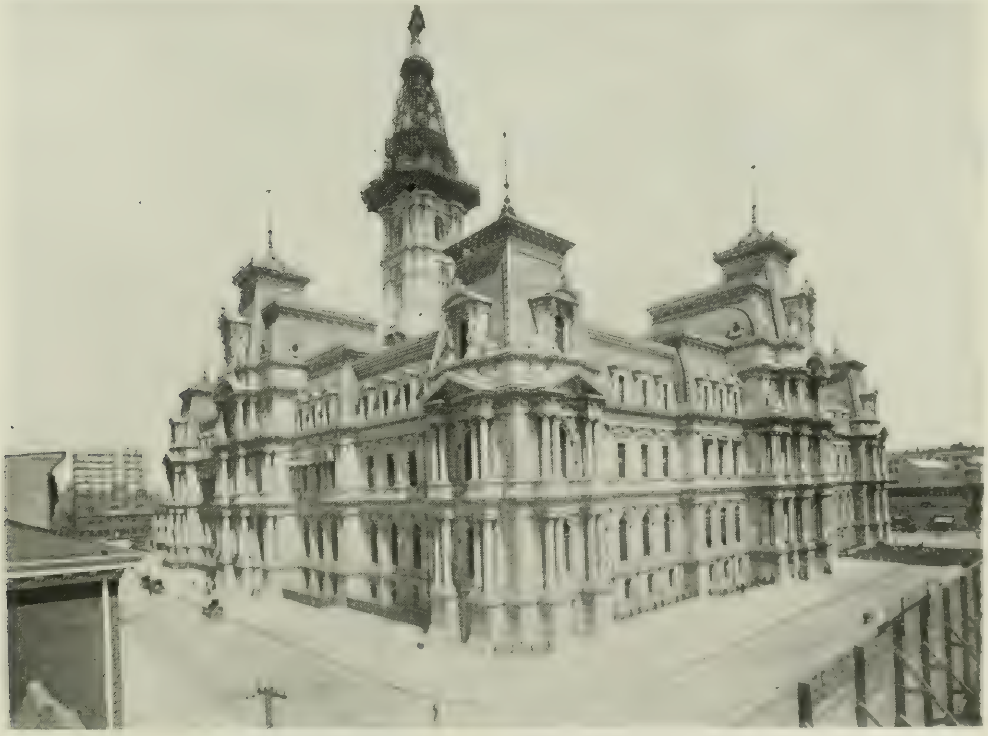
It will be observed that the system of managing labor at the Sellers establishment is extremely simple, and that the order blank and work ticket are made in such form that, when filled out, they together contain the entire history of the job to which they relate, ready for transfer to the permanent books, thus saving clerical labor, while the permanence of piece-rates relieves the rate-fixing department of an interminable task in the way of watching the piece-rate totals paid to each workman, with a view to "adjusting" such totals to lower figures at the earliest possible moment.

THE AMERICAN TALL BUILDING FROM A EUROPEAN POINT OF VIEW.

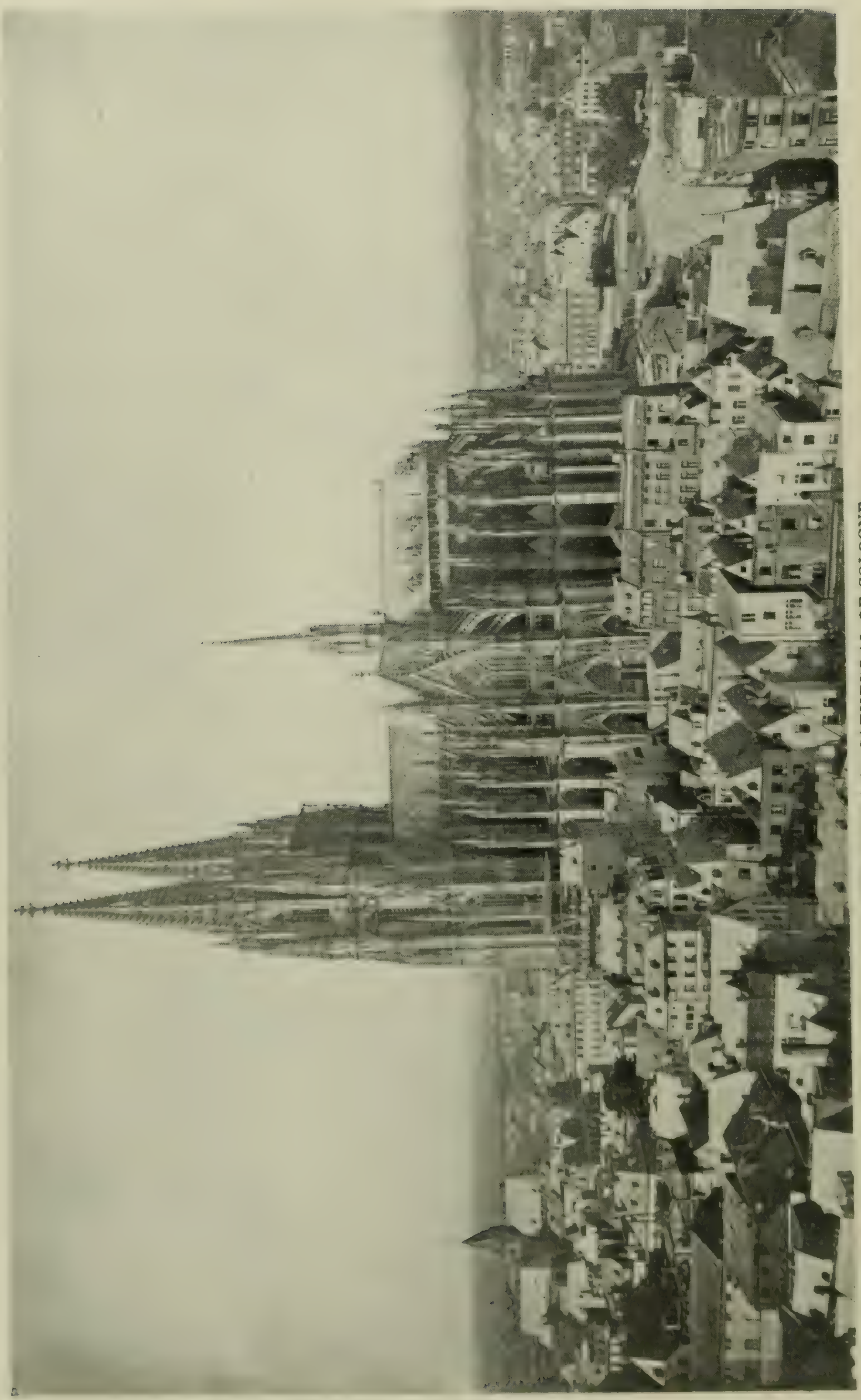
By S. Henbest Capper.

IN the "country of wonderful" (and, be it confessed, even wearisome) "distances," *tallness*, of one sort or another, is an ideal pronouncedly sought after, sometimes even held to be, like virtue, its own reward.

Of this the great tower and pinnacle of the city hall at Philadelphia are an unhappy instance. Ill-designed and crowned with a scarcely appropriate statue that is much too big,—it is said to be seventeen feet high,—this huge architectural failure has little to recommend it but its exaggerated height, which is claimed "to beat the European record." Could any ambition be more futile? Had its builders set themselves to raise a tower more beautiful than anything in Europe, and had they thus "beaten the European record," how grateful would all the world (including Europe) have been to them! And those old towers themselves, of Europe, still after so many centuries the joy of their beholders, would have borne proudly the knowledge of a younger sister more beauteous then they. But at Philadelphia success means to have distorted a design. This



THE NEW CITY HALL, PHILADELPHIA, PA.



THE CITY AND CATHEDRAL OF COLOGNE.

wondrous fallacy of beating some one else's record—borrowed, presumably from that huckstering spirit which has turned the god-like athlete of a Myron into the modern professional of the race-track and the ring—has certainly no place in architecture or in any art. It must, without fail, reduce art to vulgarity.

Take another signal instance,—the great memorial obelisk at Washington,—and compare it with its prototype. The guide-books tell us that it contains so many thousand blocks of stone, and again that it "beats the European record" by being 555 feet high. What is this obelisk after all? A huge stone casing to an elevator, aping the form of an Egyptian monolith. The obelisk, as reared on the banks of the Nile four thousand years ago, was the most stately, most appropriate form for a high memorial block of stone ever devised; and these old obelisks, graved with their brilliantly-decorative hieroglyphics, are still unrivalled. The ancient Egyptians vied eagerly in the size of these noble blocks; the largest weigh several hundred tons; those erected at Karnak by Hat-shep-sut have a fine and most interesting inscription, recording the pride of their founder in the speed and success with which her design had been carried out, and, above all, in the grandeur of scale of these obelisks she had achieved in honor of Amen. But no Egyptian ever dreamed of *building* a piecemeal obelisk to "break the record." A monolith built of little pieces is a *reductio ad absurdum*, if not a fraud, and was reserved for the glorifiers of that distinguished American who "could not tell a lie."

THE TOWN OF BURGOS, SPAIN, AND ITS CATHEDRAL.

"Tallness," therefore, as an ideal, is not necessarily right in art;

it by no means leads infallibly to artistic success. Height, when achieved with due proportion, is undoubtedly a noble quality in art, appealing deeply to the imagination ; but mere "tallness" may be as far as possible removed from well-proportioned height.

Another point, too, may be briefly noted. In matters of taste, familiarity is often an essential factor ; in architecture especially, which is, above all, the art of common sense and sobriety, to shock is not to carry ultimate conviction, and any violent departure from accepted standards must emphatically justify itself. Bewilderment is not akin to admiration, nor does gaping wonder tend to intellectual assent.

PANORAMA OF THE TOWN OF STRASBURG.

Probably to most of those who are sufficiently interested in architecture to take heed of contemporary work the "tall buildings" of New York and other cities embody America's chief contribution to modern architectural advance. They have led to new and complicated problems of construction, solved doubtless with all the energy, the boldness, and the address characteristic of American engineering. They also present esthetic problems of considerable importance and interest, the solution of which is perhaps not so apparently ready or convincing. At any rate, in New York itself, where these "tall buildings" are already fairly numerous, the divergence of design, not merely of ornamental detail, but of radical conception as a whole, is very marked. All is tentative, and all (one might almost add) attempted, for much is extravagant, tried (it seems) if haply the result may justify the trial with a success which aims at rather the clamour of advertisement than the excellence of studied and achieved design.

The problem asking for solution is an eminently modern one. Architecture cannot, on pain of proving untrue to her traditions as a living art, refuse to entertain it, to grapple with it, and eventually to reach a satisfactory solution. We must, I hold, put definitely aside the criticism so often heard: "These tall monstrosities are not architecture at all; they are only engineering, with a stone veneer." They are buildings of our modern city streets; and, if these be not architecture, where indeed *is* modern architecture to find her place? She is bound to find her own solutions for novel problems, however difficult, and to achieve a harmony between the requirements of to-day and the accepted canons of artistic sense. It is essentially in responding to the needs of modern complex life, in interpreting and meeting them, that the art itself is modern and living.

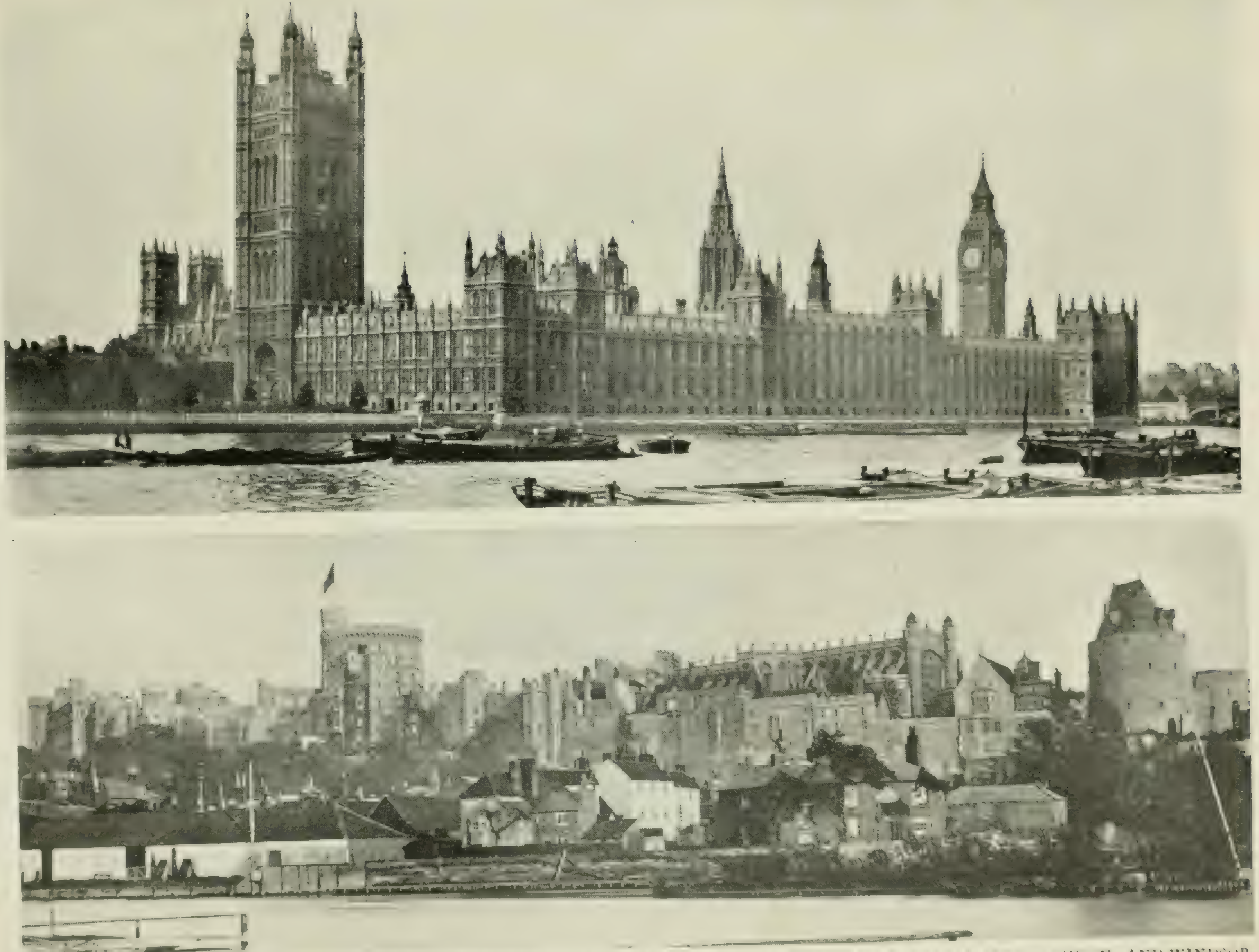
The problem is undoubtedly difficult. As usual, it reaches the architect in a somewhat advanced and complicated stage; he has to grapple with it with many data already definitely fixed and binding his design. On a restricted site of enormous initial cost, a building has to be erected of sufficient cubic capacity to "pay."

The financial problem dictates extension by way of height, which, however, creates at once constructive difficulties. These are being met and satisfactorily disposed of by the many expert engineers who have so brilliantly worked out the various novel methods embodied in the construction of these "tall buildings"; several interesting papers in regard to these have recently appeared in THE ENGINEERING MAGAZINE. New methods of foundation have been evolved, apart from which the main factor in construction is the steel-skeleton structure. The requirements of floor-space (dictated by financial needs) rigidly limit the supporting and enclosing walls to the least superficial area compatible with safety and stability. Further, the need for the maximum of light in the interior equally leads to the reduction of wall thickness and external piers, while it forces the engineer to find a substitute for the ordinary diagonal bracing and cross-ties, which are incompatible with windows. With these complicated restrictions, the architect has to design his building, fettered and hampered, or, on the other hand, inspired, it may be,—for restriction is ever a fertile cause of happy ingenuity and an occasion for success. Moreover, be it remembered, the architect has here artistic opportunity in height before undreamed of, and quite beyond his reach without the steel-framed structure, which is here the essence of his building.

In the first place, the buildings have the very great advantage of being isolated above street-level. They can, therefore, be designed as complete in themselves, in a way that no ordinary street building permits. But they are seen all round, and must be designed as a building in three dimensions, not as a mere street front. In spite of this self-evident fact, some glaring instances to the contrary are in painful evidence. The St. Paul Building in Broadway at present is so indescribably maimed in this respect that it can, presumably, be but partially complete. As it stands, a more striking instance hardly could be found of designing a front without looking round the corner, in this case the neglected "round the corner" being considerably more in evidence than the columned stories of the front itself. But any possible design would have been irretrievably ruined by the utter hopelessness of this site in shape and superficial area.

This isolation is, of course, a permanent advantage, for the buildings, to achieve their object, must remain isolated and apart; if crowded up, their lower storeys become correspondingly reduced in value. It is said that this is an economic factor that has already made itself felt; and it is quite conceivable that in self-defence the "tall buildings" will surround themselves with shorter neighbours, or, in other words, will come to be designed as only the central portions of a larger, lower block. If so, their design will be a good deal modified, probably in marked improvement. At present the lower storeys are said to be in little demand, and, as the streets, which are darkened by these buildings, are generally too narrow, it is possible that an expedient may be found corresponding somewhat to the arcaded streets of old Bologna, some portion of the ground space being given in compensation to the darkened streets, to the no small gain of the jostled foot-passenger. This would not necessarily cause the buildings to appear propped up on stilts; it would be more likely to add to the importance of the lowest storey by the pillared complexity introduced.

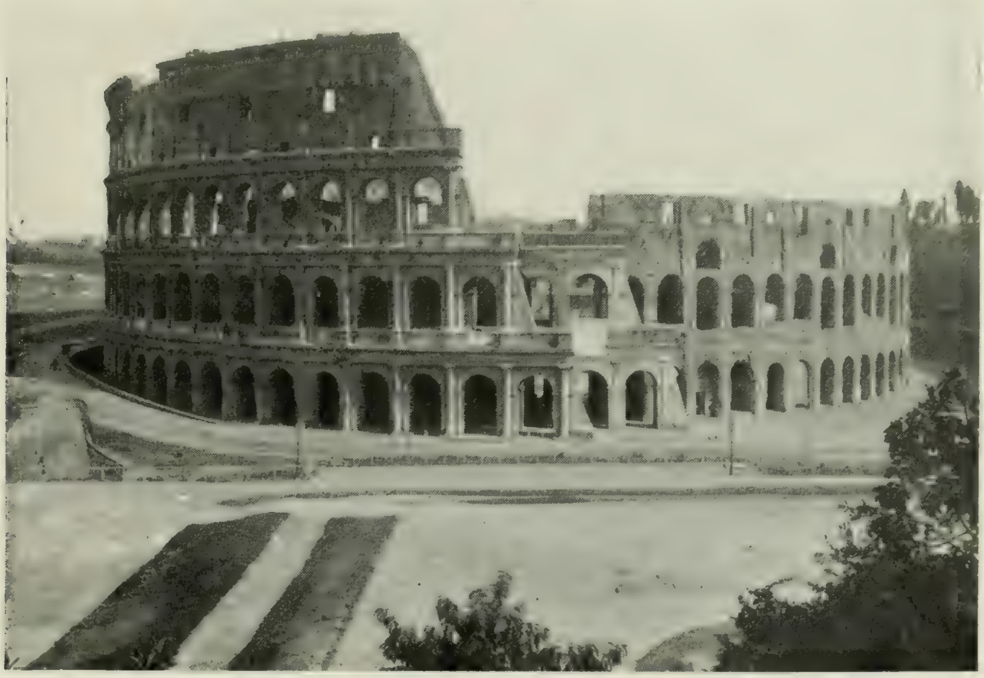
In the second place, where so great height is *de facto* attained, it seems unnecessary to emphasize it in exterior design. A good many of the buildings are designed on the principle of strongly vertical lines carried through many storeys. This I venture to think a mistake. It is right for a comparatively slender tower, undoubtedly, where the sole object is height; every one will recall the noble campanile of St. Mark's at Venice (in the lower and comparatively early portion), as well as many others. These "tall buildings," however, in spite of their tallness, are by no means towers; they are spacious



TWO DOMINATING BUILDINGS ON DIFFERENT REACHES OF THE THAMES—THE NEW HOUSES OF PARLIAMENT, LONDON, AND WINDSOR and habitable buildings ; to design them as towers is a twofold mistake, both practical and esthetic ; it is their openness, their brilliant lighting, their spaciousness, that should be emphasized, and that can best be done by horizontal treatment of the storeys. Moreover, such a treatment would be, perhaps, more in accord with their construction. It is one of the misfortunes of their steel-skeleton construction that it must all be, perforce, concealed. The material, unless buried in a fire and weather-resisting shell, is extremely ephemeral and unenduring. Consequently, the architect lacks that guidance of dominant construction which goes so far to make a design coherent, logical, and easy to interpret. Yet it is a fact that these great buildings are erected in horizontal stages, comprising, it may be, several storeys each, but still well-defined platforms, or stages. And these should surely be seized upon, if practicable, and interpreted in the exterior design. It seems to me that in this way the buildings would very greatly gain in meaning and expression. A word or two may here be suggested in regard to this construction from the esthetic point of view. Since the Gothic revival, with its battle-cry of "ornamented construction" and its decry of "constructed ornament," it is natural and inevitable, and surely right, to seize first on genuine construction to be interpreted and expressed in a design. Where, then, is there room for this totally-concealed construction ? Some would, of course, deny *in toto* its right architecturally to exist ; metal cased in stone, they claim, is a quite illegitimate method of architectural construction, being a sham of the most flagrant kind. To deny, however, to iron and steel the position they have conquered in the world of modern construction is, of course, wholly futile. But from their perishable nature they must be hidden away for their own protection. How, then, are they to be dealt with ? The most obvious method is to case the metal in some form of plastic material, such as terra-cotta ; steel construction, thus treated, is quite capable of honesty above reproach. Whether stone is a wholly legitimate substitute for a plastic material thus required to case it in is a good deal more open to question. It is certainly more costly, and more difficult to handle ; above, all it is a less natural material, when so used. We are all so thoroughly accustomed to stone, "solid stone," as a material for the most durable, the most massive, and the most solidly constructed buildings, that it is certainly a shock to see it cramped on to a steel backing, treated like a veneer, pared down, and pinned and bolted into place. This is certainly not material used in its natural way ; it is so unnatural, and shocks so irretrievably, that I very much doubt if it can be accepted esthetically as so satisfactory as a wholly plastic material.

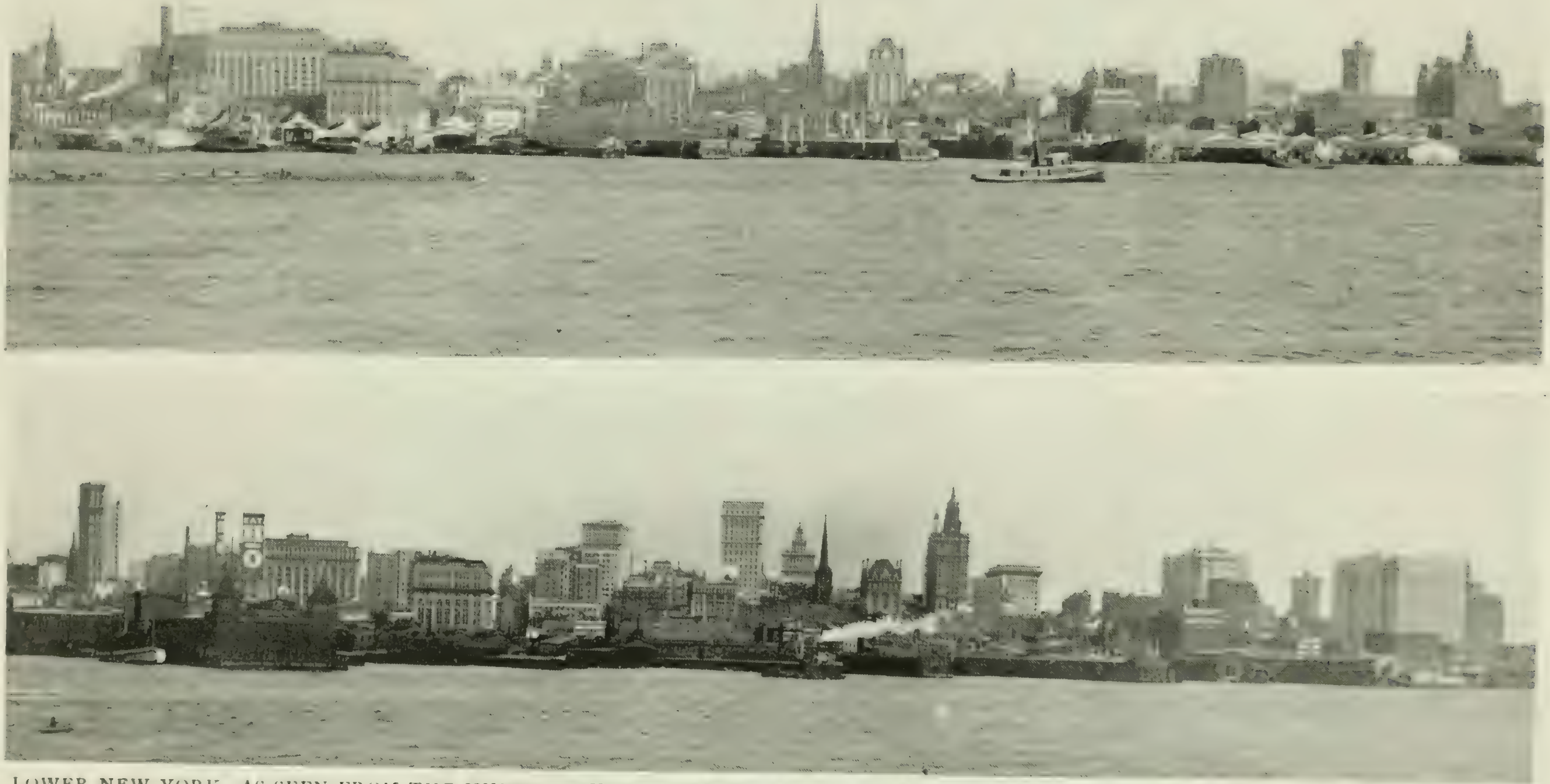
On the other hand, it may be legitimately contended that with stone one can get both colour and texture, which are not to be had in any terra cotta or similar material. These are the two sides of a controversy incapable, it seems to me, of dogmatic decision; but I return to the craving at least for horizontal lines in the masonry as opposed to vertical, more especially if these can be made to interpret something of the method of construction in horizontal stages.

In the third place, much and lavish exterior ornament seems wholly out of place. The buildings are themselves so large and so imposing that they do not require enrichment to give them interest; mere surface ornament becomes unmeaning and superfluous; when used on so large a building, it becomes mere frittered labour, painful from its ineffectiveness. Many of the "tall buildings" of New York are rather lavishly ornamented, but the ornamentation is ultimately felt to detract from, not to enhance, their size. The truth is that, in a very large building, an almost monotonous repetition is of potent artistic value. Of this the Flavian Amphitheatre at Rome, the so-called Colosseum, is a well-known instance. The steady repetition of the same architectural motive, in an apparently endless series of arcades with engaged columns between, impresses the beholder with an irresistible majesty. Something of the same effect seems attainable in these tall buildings, with their monotonous repetition of similar window openings. And any ornamentation disturbs the resulting impression of



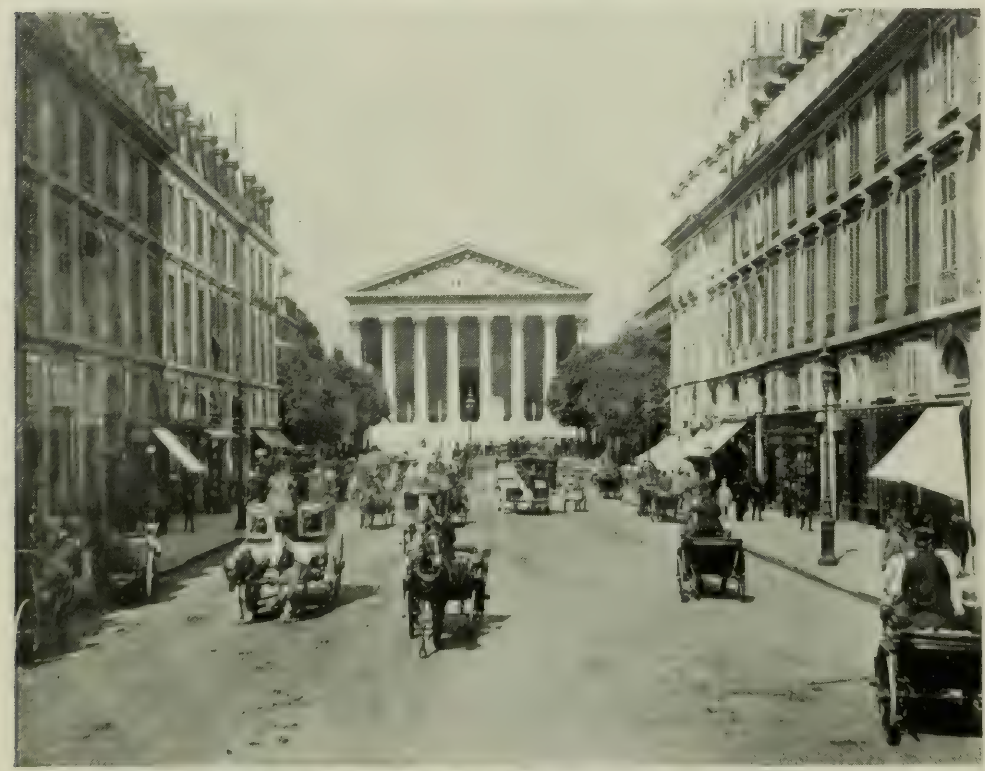
THE COLOSSEUM AT ROME.

solidity and power and scale. It is noteworthy that the "tall buildings" of old Edinburgh, somewhat famous in their way, are totally devoid of architectural ornament, though singularly effective in the fair city architecture of the "Modern Athens." The most recent type of the "tall building" in New York seems to relegate the ornamentation to the base storeys just above the street and to the top, or crowning, storeys. As has been mentioned, the lower storeys are said to be of inferior letting value, and are not, therefore, very naturally selected for extra cost in execution. But probably the temptation to enrich the storeys within fair reach of the eye from the street-level is strong, and artistically is defensible. Above all, the main entrance naturally calls for emphasis and enrichment; one does not expect to enter so imposing a building by any mean or insignificant doorway. The cornice is a great difficulty; it has not, it seems to me, as yet been adequately studied out. In so huge a block of building, it should have a projection unattainable in practice. In Florence the Strozzi Palace (though only a portion of the grand cornice has ever been completed) is a very fine example of a simple cliff-like façade crowned by a rich and noble cornice. In Rome one turns naturally to the grand cornice of the Farnese Palace, in competition for which Michael Angelo waxed so mightily indignant. Both these are classical examples, to which might be added, in more recent times, the Arc de Triomphe at Paris. But beyond this limit it is not possible to go in stone. What, then, are the designers of those "tall buildings" to do? The course generally adopted has been to use metal in place of stone; but the result is necessarily either fraudulent, in so far as the change from stone to metal remains undetected, or hybrid, as a patchwork of materials; neither alternative is satisfactory. I venture to suggest that it is preferable to abandon the attempt (which must be futile) to obtain exaggerated overhang, and to substitute therefor vertical depth; by restudying the cornice in this sense, including a storey or more in the depth of the cornice and its members, I believe a more satisfactory and a wholly legitimate result would be obtained. For this, too, we have an eminently successful classical example. The famous cornice of Vignola, with its deep consoles, will be readily recalled. Vignola, on a small scale, had the same problem to solve, and he solved it most judiciously by increasing his cornice in vertical depth without exaggerating the overhang. Modifications of this cornice are constantly used in modern French street architecture with happy effect; and, if a leaf were taken from the old Italian's book, though not without much study, there could doubtless be evolved a more suitable cornice for a "tall building" than by flying to metal and treating us to gilded gingerbread and tinsel two hundred and fifty feet above our heads.



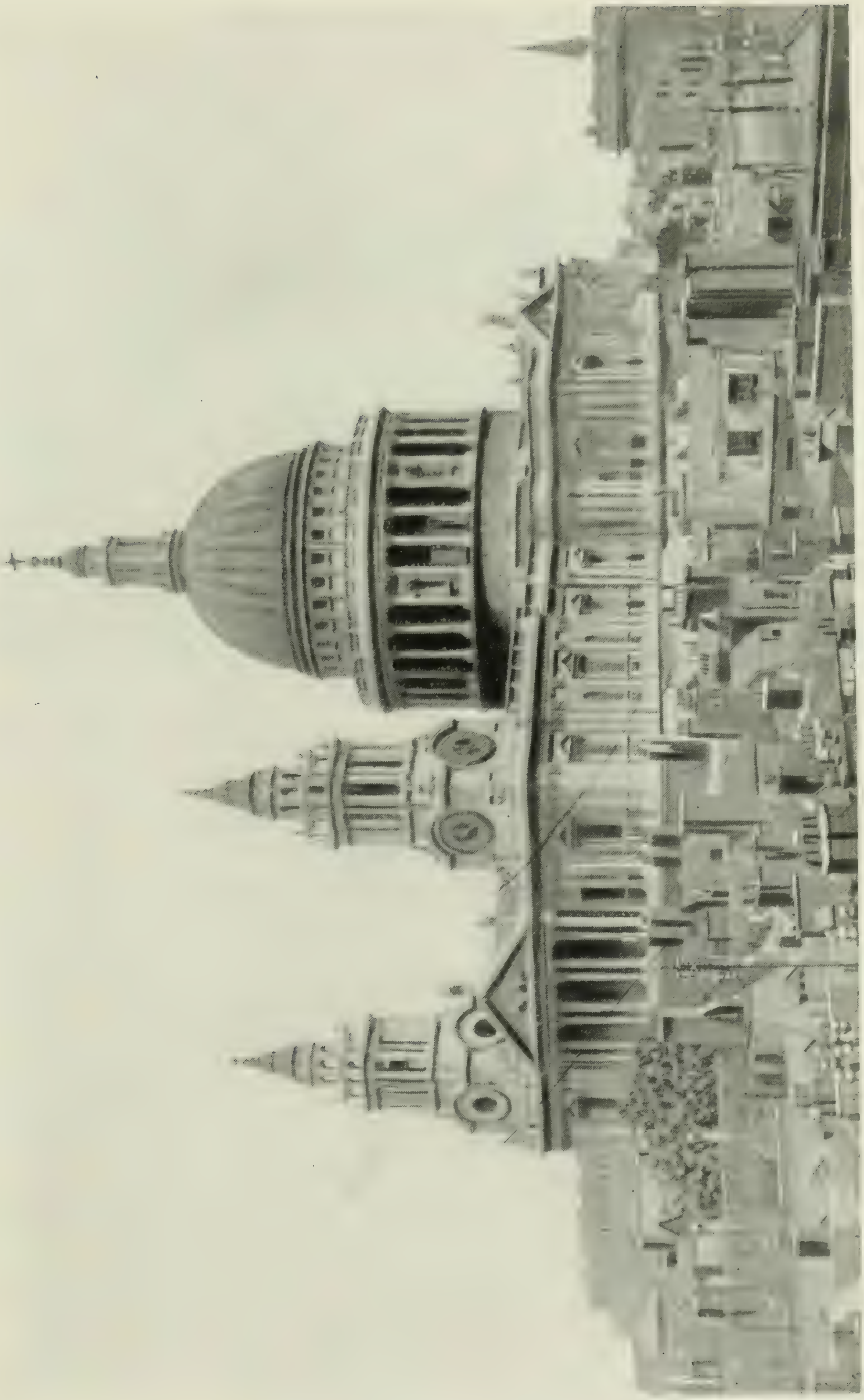
LOWER NEW YORK, AS SEEN FROM THE HUDSON RIVER. THE UPPER VIEW WAS TAKEN ABOUT 1891, WHILE TRINITY CHURCH SPIRE WAS STILL THE CULMINATING POINT OF THE SKY LINE. THE LOWER VIEW WAS TAKEN IN THE SPRING OF 1897, AND SHOWS THE CHURCH ENGULFED IN THE SURROUNDING HIGH BUILDINGS.

It remains to add a word in regard to the effect of these "tall buildings" upon the appearance of the city as a whole. So long as they were few in number, they are said to have given New York a very ragged sky-line, unkempt, so to speak, and unpleasing. Now that they are fairly numerous, this seems no longer the case. The general raising of height—a result of modern city development by no means confined to New York—has necessarily tended to submerge many a worthy building that formerly rose tall and stately above its surroundings. An extreme case is Trinity Church, New York, a very sober and quiet study in perpendicular Gothic, the graceful spire of which formerly rose clear, a notable landmark of the city. It is now completely submerged and lost, rising, as it were, in slender effort, stifled in a sort of well. But this is painfully true of other cities, too. All visitors to Paris know how the Church of the Madeleine is now felt to be too low for its surroundings; how much it would gain by being raised above the houses that hem it in! In London also many of Wren's fine steeples are now almost equally engulfed and lost.



THE MADELEINE, PARIS, SEEN FROM THE RUE ROYALE.

Nothing can excel the noble approach to New York; it is undoubtedly one of the fine harbours of the world. But the city itself is totally destitute of "heights." This lack the modern "tall buildings" certainly go some way effectively to make good, and I cannot but feel



ST. PAUL'S, LONDON.

FLORENCE. THE CATHEDRAL AS SEEN FROM THE CUPOLA OF SAN LORENZO.

sure that in sky-line and general appearance from the harbour New York has gained from them.

That such would be the case elsewhere is not so certain ; New York, from its original flatness, is perhaps a special case. It is comparatively easy to dwarf nature ; and one of these tall buildings, judiciously planted so as to spoil a natural landmark, could achieve without difficulty the total and fatal ruination of a noble scene. It is dreadful, for instance, to imagine the Acropolis of Athens girt around with buildings like those in Broadway. Imagine Siena, her valleys enriched with " tall buildings " sprouting high above that fair Duomo which so nobly crowns her highest rock ! Imagine Florence, nestling by the Arno under the heights of Fiesole and the distant girding Apennines,—imagine Florence, now so fair, sleeping under Giotto's campanile and Brunelleschi's dome, were she to awake and find her Duomo dwarfed and thrown into the shade by a ring of New York tall buildings of the latest type, or of Chicago sky-scrapers !

Wren's noble dome, though somewhat dwarfed in height by its modern surroundings, nevertheless still floats in fair serenity, majestically crowning murky London. I cannot think that " tall buildings " are architecturally wanted in any of these cities ; sufficient unto America be the " tall buildings " thereof.

THE ENORMOUS POSSIBILITIES OF RAPID ELECTRIC TRAVEL.

By Charles Henry Davis and F. Stuart Williamson.

II.

IN THE ENGINEERING MAGAZINE for October we outlined the engineering problems which must be solved to enable trains to be run at a speed of 170 miles or more per hour, discussing a specific case,—namely, a road on which trains should run from Philadelphia to New York harbor (a distance of 85 miles), without stops, in 36 minutes. It is the purpose of this paper to discuss the cost or the probable return from the investment. The assumptions (in addition to those in the first paper) have been made a basis for our figures:

(*a*) That the heaviest trains consist of five cars and can be safely stopped within 11,223 feet, when running at their maximum speed of 170 miles per hour; (*b*) that subsections (see signal diagram plate No. 3, first paper) would therefore be 11,223 feet long, and section signal towers 44,892 feet (8.5 miles) apart; (*c*) that central power stations are located at section signal towers and at each end of the line, eleven in all, and that rotary transformer sub-stations are located at sub-section signal towers, thirty in all; (*d*) that there are three tracks, the middle one being used for trains from Philadelphia to New York in the morning hours and for trains from New York to Philadelphia in the evening hours, and as an emergency track; (*e*) that a three-minute headway on each track could be maintained without danger, the trains being 8.5 miles apart and capable of being stopped within 11,223 feet; (*f*) that trains could, therefore, leave terminals every minute and a half during hours of heaviest traffic; (*g*) that, therefore, sixty trains would perform the service, or, allowing the necessary margin for delays, repairs, and waits, eighty trains (400 cars) would properly equip the road; (*h*) that each terminal has ten tracks, allowing a minimum of fifteen minutes for examination and shifting of each train before returning it; (*i*) that each terminal has room for eighty trains, not including tracks on lifts; (*j*) that the right of way is one hundred feet wide; (*k*) that tunnel excavations amount to 3,750,000 cubic yards, and cuts to 3,000,000 cubic yards, and that there are fills to balance cuts and tunnels; (*l*) that 10,000 volts of three-phase current is used on transmission lines, and 1,000 volts of direct current on feeder systems; (*m*) that each train will require not more than 10,000 i. h. p. at the station under economical conditions, the maximum capacity being about fifty per cent. greater; (*n*) that each station has an economical capacity of 30,000 i. h. p., with a maximum fifty per cent. greater, and each sub station an economical rating of 20,000 i. h. p. and a maximum fifty per cent. greater.

FIRST COST:

(*a*) RIGHT OF WAY AND REAL ESTATE:

1. New York terminal,	720,000 sq. ft. av.	$20.00,	$14,400,000	£2,880,000
2. “ “ r. of w.,	300,000 “ “ “	10.00,	3,000,000	600,000
3. Elizabeth r. of w.,	528,000 “ “ “	1.00,	528,000	105,600
4. Woodbridge r. of w.,	528,000 “ “ “	.50,	264,000	52,800
5. Trenton “ “	792,000 “ “ “	1.50,	1,188,000	237,600
6. Phila. “ “	1,584,000 “ “ “	2.00,	3,168,000	633,600
7. “ terminal,	750,000 “ “ “	5.00,	3,750,000	750,000
8. Balance of r. of w., 800 acres at $1000,			800,000	160,000
9. Power house and sub-station real estate,			440,000	88.000
Total,			$27,538,000	£5,507,600

(*b*) CONSTRUCTION:

1. Engineering, 2% on $150,000,000............	$3,000,000	£ 600,000
2. Clearing, 200 acres at $100..................	20,000	4,000
3. Grading, ditching, etc., to sub-grade 2,000,000 yds. rock at $1.00, 500,000 yds. hard pan at 60 cents, 500,000 yds. earth at 35 cents......	2,475,000	495,000
4. Tunnels, 3 tubes including vertical shafts, each 59,136 feet long at $200 per foot each........	35,482,000	7,096,400
5. Masonry, culverts, bridges, viaduct, as per profile complete, ready for rails...............	13,675,000	2,735,000
6. Fencing and 60 road crossings..	1,300,000	260,000
7. Ballasting 20 cu. yds. broken stone at $1.00 and 7.5 cu. yds. of concrete at $3.00 per foot of line for 264,000 feet.........	11,220,000	2,244,000
8. Ties, steel 1000 lbs. per ft. of line, 448,800 feet at $15 per ton..........................	3,366,000	673,200
9. Rails and fastenings 300 lbs. per yd. at $20 per ton of rail delivered...........	2,693,000	538,600
10. Track laying, lining and surfacing, and placing on viaducts 255 miles of single track at av. $3,000................	765,000	153,000
11. Rail bonding 44,880 joints at $20...	898,000	179,600
12. Third rail and supports, 3–300 lb. steel rails 74,800 steel supports at $10...............	2,094,000	418,800
13. Signals at $20,000 per mile..................	1,700,000	340,000
14. Telegraph at $5,000 per mile	425,000	85,000
15. Stations and buildings (except terminals) 11 power stations at $70,000, and 30 sub-stations at $10,000............	1,070,000	214,000
16. Terminals, each 72,000,000 cu. ft. at 10 cents..	14,400,000	2,880,000
Total..............	$94,583,000	£18,916,600

(*c*) EQUIPMENT:

1. Locomotives and tender (none)	....	....
2. Motor cars 400 at $20,000, equipped with not more than 2,000 h. p. each	$8,000,000	£1,600,000
3. Passenger cars (included under No. 2)	....	....
4. Freight cars (none)	....	....
5. Electric feeder lines and ground returns (rails with bonding form sufficient return), feeders 14,400,000 lbs. at 15 cents in place, transmission line 7,040,000 lbs. at 15 cents in place, pole line, 8,976, with material and concrete at $50 each in place	3,665,000	733,000
6. Central power stations and sub-stations, 11 c. p. s. of 30,000 h. p. each at $40 and 30 s.-s. of 20,000 h. p. each at $5 each	16,200,000	3,240,000
Total	$27,865,000	£5,573,000

(*d*) GENERAL:

1. Discount on $100,000,000 3% 100-year bonds	$5,000,000	£1,000,000
2. Interest on bonds to opening of road, say, 10 years of construction averaging 10 millions per year at 3%	16,500,000	3,300,000
3. Taxes to opening of road, assuming ¼ assessment and 2% rate	5,500,000	1,100,000
4. Office expenses, salaries, etc., to opening of road 2% on 150 million	3,000,000	600,000
5. Contingent, etc., not itemized, to opening of road 5 6%	10,014,000	2,002,800
Total	$40,014,000	£8,002,800

SUMMARY:

(*a*) Right of way and real estate	$ 27,538,000	£ 5,507,600
(*b*) Construction	94,583,000	18,916,600
(*c*) Equipment	27,865,000	5,573,000
(*d*) General	40,014,000	8,002,800
Grand total ($745,098 per mile of single track)	$190,000,000	£38,000,000

The proposed line has not been surveyed, and our plan and profile (maps No. 1 and No. 2, first paper) were prepared from United States government and State maps, the scale not exceeding one inch to the mile. Were a careful survey made, additional curves and heavier grades could undoubtedly be used, tending to greatly reduce the estimated cost given herein. These improvements would probably balance those items which almost invariably cause the final cost of a line to exceed the estimated cost. In every case liberal figures have been used, so that the writers feel confident that an over-estimate has been made.

One might be inclined to think a cost of $190,000,000 excessive, were it not for the favorable comparison which can be made with the proposed rapid transit road for New York city at an estimated cost of $50,000,000 for less than 50 miles of single track (probably the cost of this road will be far greater than $50,000,000), or with the investments of the Pennsylvania and the Reading Railroad Company's lines between the two cities here considered. The United Railroads of New Jersey are assessed in New Jersey at about $50,000,000, the Central Railroad of New Jersey at about $35,000,000, and the Philadelphia & Reading Railroad at about $5,000,000. The figures in each case are approximate, and for that portion of the lines operated between New York and Philadelphia, not including other portions of the systems. Assessments in New Jersey are usually from twenty to forty per cent. of the actual value of the properties; assuming the higher figure, and allowing one-half additional for the value of the lines from the Delaware river to Philadelphia, with the same average assessment, we find:

Pennsylvania R. R., New York to Phila., value $187,500,000, £37,500,000.

P. & R. R. R. and C. R. R. of N. J., New York to Phila., value $150,000,000, £30,000,000.

Probably these figures are too low.

The proposed car would seat 140, so that a train of five cars would carry 700 passengers, seated; the maximum capacity in seated passengers would, therefore, be 28,000 per hour, or 466 per minute. Assuming the following percentage of travel, which closely conforms to experience on several suburban, elevated, and inter-urban lines, we have:

28,000 pass. per hour for 2 hours=maximum=56,000 pass.
5,600 " " " " 2 " =20% of maximum=11,200 pass.
2,800 " " " " 7 " =10% " =19,600 "
840 " " " " 8 " = 3% " = 6,720 "
19 " total pass. one way= 93,520 "
total pass. both ways=187,040

Making allowances for excursion loads, standing passengers, and empty seats during light hours, and assuming the above average maximum, the road should carry, in round numbers, 200,000 passengers per day, or 73,000,000 passengers per annum; the United Railroads of New Jersey carry to-day about 18,000,000 passengers, the Central Railroad of New Jersey about 12,000,000, and the Philadelphia & Reading about 17,000,000, or a total of 47,000,000. This, however, includes all passengers, whether local, commuters, or otherwise. The records do not show the totals between the points under discussion. These figures are of no special importance, for the laws which will govern travel on the proposed road do not apply to existing roads between these points.

The schedule, headway, car mileage, etc., necessary to the carriage of this number of passengers, are shown in the following table:

Leaving Headway Min.	Track Headway Min.	No of Cars to each train.	No. of Trains per Hour.	No. of Cars per Hour.	No. of Hours.	Total Cars Run.	Car Miles.
1-1½	3	5	40	200	2	400	34,000
6	12	4	10	40	2	80	6,800
6	6	2	10	20	7	140	11,900
6	6	1	10	10	8	80	6,800
				(One way)		700	59,500

A daily total of 119,000 car-miles gives a yearly total of 43,435,000 car-miles, or 1.68 passengers per car-mile; as there are 500 trains per day, or 182,500 per year, we have 15,512,500 train-miles per annum, 4.70 passengers per train-mile, and 6,205,000,000 passengers carried one mile. Our trains average 2.8 cars each.

Below we give a table showing a fair distribution of operating expenses per train-mile by percentages of the whole (column No. 1), as obtained under ordinary steam-railway conditions. Column No. 2 gives the estimated reductions or additions for the proposed system, due either to the actual savings which should be realized on account of heavier and more substantial construction, or to the elimination of certain items by the changed conditions. These figures are based upon the probability that the cost per car-mile will closely approximate present practice, for, while fuel account and some other items will no doubt be increased, they are insignificant in comparison with the large saving in labor account, owing to the high speeds maintained and omission of local stations.

			Col. No. 1.	Col. No. 2.
(*a*)Maintenance and renewal of way and works.				
	1.	Repairs of earthwork to sub-grade	1.5	1.5
	2.	“ “ track	8.2	5.0
	3.	“ “ fences, crossings, etc.	.3	.2
(e)	4.	“ “ ground return circuit	—	*
(e)	5.	“ “ third rail	—	*
(e)	6.	“ “ feeder lines	—	*
	7.	Renewal of rails	4.0	2.0
	8.	“ “ ties	3.0	.5
	9.	“ “ ballast	1.0	1.0
(e)	10.	“ “ poles and insulation of third rail	—	*
(e)	11.	“ “ third rail	—	*
(e)	12.	“ “ feeders	—	*
	13.	Repairs “ masonry, bridges and trestles	2.0	1.5
	14.	“ “ buildings	2.0	2.0
	15.	“ “ signals	1.0	1.3
		Total,	23.0	15.0

	(*b*) Train expenses.		
(s)	1. Fuel for locomotives	8.0	—
(e)	2. " " power stations	—	*
	3. Water-supply	.6	1.0
	4. Oil and waste	1.0	1.0
(s)	5. Repairs ot locomotives and tenders	6.0	—
(e)	6. " of electric motors	—	*
	7. " of passenger cars	3.0	3.0
	8. " of freight cars	6.0	—
	9. Use of foreign passengers and freight cars	2.0	—
(s)	10. Locomotive services (wages)	7.4	—
(e)	11. Motor car services (wages]	—	3.0
	12. Passenger train services (wages)	3.0	1.0
	13. Freight train services (wages)	5.0	—
(e)	14. Repairs of power plants	—	*
(e)	15. Power station services [wages]	—	*
	Total,	42.0	9.0
	(*c*) Station, terminal, taxes, and general expenses.		
	1. Agents and station services (wages)	13.0	3.0
	2. Station supplies	3.0	.5
	3. Telegraph	1.0	1.0
	4. Taxes	3.5	3.5
	5. General officers and clerks	3.5	2.0
	6. Legal	.5	.5
	7. Insurance	.3	.3
	8. Stationery and printing	.7	.2
	9. Agencies and advertising	2.0	.5
	10. Contingent and miscellaneous, not included elsewhere	6.5	6.5
	Total,	34.0	18.0
	(*d*) Accidents, loss, and damages.		
	1. To freight	.3	—
	2. To passengers	.4	.4
	3. To property owned	.2	.2
	4. To property not owned	.1	.1
	Total,	1.0	.7

NOTE: (s) indicates the item that applies to steam road only.
(e) " " " " " electric road only.
— " " " does not apply in that column.
* " " " is to be added later.

SUMMARY:

(Figures give %.)	(*a*)	(*b*)	(*c*)	(*d*)	TOTAL.
Column No. 1	23	42	34	1	100
Column No. 2 (omitting items applying to an electric road only)	15	9	18	.7	42.7
Column No. 2 (per cent. difference from Col. No. 1, being allowance for items applying to electric roads only)	8	33	16	.3	57.3

By examination of the above table it may be seen that our proposed road should save 57.3 per cent. of the expenses of the present steam railway, and that this saving can be used to provide for these items belonging to the electric road only,—namely, (*a*) 4, 5, 6, 10, 11, and 12, and (*b*) 2, 6, 14, and 15.

We can take the cost per train-mile in present steam-railway practice at 60 cents, or 2 shillings 6 pence; considering the engine as a car and considering a train as made up of four cars behind the engine, we have 12 cents, or 6 pence, per car-mile as the average practice on a well-managed steam railway. If the above savings balance the additional items chargeable to the electric road, the expenses would be the same. An examination of the items leads one to believe that they would; let us assume, however, that our expenses would be not less than 15 cents per car mile, or twenty-five per cent. higher than those of present steam-railway operation. Car labor on our present street railways, with short headways, amounts to about 42.5 per cent. of the total cost per car-mile at a speed not exceeding fifteen miles per hour, theoretically varying inversely as the speed. Remembering the high speed proposed, the estimate of cost should not be far from the truth. The total operating expenses would, therefore, amount to $6,515,250 (£1,303,050) per annum. To this must be added (*a*) interest on floating debt, (*b*) interest on bonds, and (*c*) sinking fund. We may assume that, if the road were financed on a sound basis, somewhat after the policy of the Pennsylvania Railroad, $100,000,000 of gold bonds would be issued, running for 100 years at three per cent., $100,000,000 of preferred non-cumulative four per cent. stock, and $100,000,000 of common stock. On this basis the additional charges would be about $3,750,000 per annum, making the "total expenses" per annum about $10,265,250 (£2,053,050). Add to this a dividend of four per cent. ($4,000,000) on the preferred stock, leaving the common stock earnings to the future, we have a total of $14,265,250 (£2,853,050) per annum as the gross receipts which must be obtained to make the enterprise a paying investment. The gross receipts from 73,000,000 passengers per annum at 20 cents (10d) each would be $14,600,000. Summarizing, we have:

Gross receipts	$14,600,000	£2,920,000	100%
Operating expenses	6,515,250	1,303,050	44.6%
Fixed charges	3,750,000	750,000	25.6%
Profits	4,334.750	866,950	29.8%

Comparing the percentage results with present steam-railway returns, we seem to be low in operating expenses, high in profits, and about right in fixed charges, while, comparing with street-railway returns, we are low in fixed charges and operating expenses and high in profits. Such comparisons lead to erroneous conclusions, for percentage of gross receipts is always improperly used, and often leads to unfortunate conclusions. This is readily seen by asking the question: "What would the expenses be, were the same car-mileage maintained and there were no passengers (gross receipts)?" the obvious answer being that they would not change materially.

Statistics do not give exact figures of the travel between terminals on the two steam roads connecting the cities, but, assuming twenty trains of five cars each in each direction on both roads, with allowances for empty seats, it is conservative to place the fares at 5,000 per day, which, at $2.00 each, give annual gross receipts of $3,650,000, the total number of passengers being 1,825,000. (United Railroad of New Jersey returned $6,906,923.59 receipts from passengers in 1895.) Where present steam railways have been paralleled by electric roads, giving quick, frequent, and "leave-at-your-door" service, with low fares, not only has the steam road lost its local traffic, but the electric road has induced a travel which did not exist. The increased travel of the electric road has been anywhere from fifty to several hundred times the former travel on the steam roads, depending upon local conditions, and in most cases with a difference in fares in a ratio not exceeding 1 to 4. In the suggested case the fares are as 1 to 10, and, should forty times the passengers assumed as riding now be carried, the gross receipts would amount to that estimated. Looking at it from another standpoint, we have the following table:

Road No.	Total Pop. of Towns Connected, U. S. Census 1890.	Total Passengers Carried 1896.	No. of Rides per Capita per year of total Pop.
1	504,204	26,791,811	53
2	149,762	8,205,411	54
3	41,937	2,366,481	56
4	37,210	1,453,567	38
5	37,185	1,114,245	29
6	34,375	1,388,968	40
7	29,306	2,148,723	73
8	23,745	1,367,851	57
9	20,638	508,172	24
10	18,887	986,608	52
11	17,693	468,472	26
12	16,418	1,015,797	61
13	16,311	1,033,977	63
14	15,714	912,930	58
15	14,884	1,022,432	68
16	13,137	1,309,421	99
17	10,887	813,689	74
18	9,473	1,426,690	150
19	8,973	655,556	73
20	5,721	684,654	119
21	5,451	738,529	135

The population connected in this case will amount to 5,500,000. If this population should be carried fourteen times, it would give the numbers of fares estimated. The lowest number given in the table, 24, would produce 132,000,000 fares, and the highest, 150, would give 825,000,000 fares for the case under discussion.

The fundamental and principal laws of electric-railway passenger travel, either within one community or between two communities, can be stated as follows:

1. It varies directly with the population, increasing faster than the inhabitants, unless modified by distribution or density.
2. It varies inversely with the average distance (time) each passenger is carried, presumably more rapidly than these shorten; distance and time are synonymous, for the result to the passenger is the same, whether he is carried 85 miles in 36 minutes, or only 12 miles.
3. It varies directly with the frequency of the service, presumably with a rapidity less than that with which headway is shortened.
4. It varies directly as the approach to "leave-at-your-door" service, but according to no known law.
5. It varies indirectly with the total cost of transportation, increasing less rapidly than the total cost falls; note that "total" cost is the important factor, and not the cost per mile.
6. It varies directly as the density of the population, the increase being probably less rapid than the increase of density.
7. It varies with the distribution of population. A long, narrow town gives more rides *per capita* per annum than a square town.
8. It varies with the character of the industries in the community.

One might argue that Philadelphia, with its 1,500,000 inhabitants, and its resources making it independent, would not conform to these laws. If this were a valid argument, it would equally apply to cities of more than 100,000 people. The last table, however, disproves this.

We believe that we have shown that headway and power questions can be solved, and that the cost of construction is not excessive; we have estimated expenses liberally, and have under-estimated probable travel; and we are convinced, for reasons that cannot be discussed now, that even a higher speed can be maintained, thus reducing the elapsed time and adding to the chances of success, but necessitating more tracks. The elimination of the distance by reduction in time would unquestionably make Philadelphia one of the suburbs of New York, for the former is naturally a manufacturing and agricultural center, while the latter is the financial and commercial center of the United States. The tendency of the age is concentration at centers, not only of population, but of wealth and special vocation, with the necessity of rapid inter-communication.

THE ECONOMICAL GOVERNING OF STEAM ENGINES.

By John S. Raworth.

WHEN James Watt bequeathed the steam engine to the human family, it was as nearly perfect as the materials at command and the conditions of its manufacture permitted. It was fitted with a speed-governor, the excellence of which is attested by the fact that, so long as engineers were limited by low pressure, no better governor was required or sought ; even the exigencies of high pressure and high speed have not yet driven or induced inventors to abandon the main principle of Watt's governor.

All governors control speed by varying the mean pressure applied to the pistons of the engine, either by throttling the supply or by varying the time during which in each stroke the full pressure is permitted to have access to the cylinder ; but the controlling mechanical device always includes two equal and opposite masses revolving round a shaft or spindle driven by the engine, the centrifugal forces of the said masses being opposed by gravity or springs.

The secret of good governing—*i. e.*, perfect regulation of speed—is now so well known that disquisitions on the construction of governors have ceased to command the interest with which at one time they were followed. The outcome of experience is that the power of a governor must be so great that its own internal friction plus the external work it has to perform shall be a negligible quantity. This fact being well understood, the chief interest nowadays centers in the economic problems involved in the two available methods of governing,—namely, throttling, and automatic variation of expansion. While there is no doubt that Watt is the father of the former, it is equally certain that we are indebted to Corliss for the latter.

Corliss achieved his success through a clear appreciation of the principle, or, rather, the limiting condition, enunciated above. He reduced the external work imposed upon the governor to an infinitesimal amount, thus leaving the centrifugal part of the arrangement little or nothing to do but to overcome the friction of its own joints.

The Corliss engine, however, reigns supreme, not simply because it maintains an even speed, but rather because that more excellent feature is combined with the highest development of the economic advantages derivable from the automatic variation of expansion. But an engine may be governed by "automatic expansion" without any development of its economic advantages ; thus the door is opened to controversy, and the whole question of throttling versus automatic expansion is being discussed anew, as though we were not the sons of our fathers, who all died in faith.

Perhaps the most curious feature of this controversy arises out of the fact that it originated in Willans, or, more correctly, that the state of mind which has rendered such controversy possible is due to a complete misunderstanding of Willans's work and teaching, for Willans's two classical papers, read before the Institute of Civil Engineers in 1889 and 1893, respectively provide the most complete armory of weapons for the discomfiture of all advocates of throttling, and the value of the facts brought to light by the tabulated results of the experiments is only enhanced by Mr. Willans's deductions therefrom, showing that the advantages to be derived from automatic expansion may very easily be lost by bad design or careless construction.

The adaptation of the steam engine to the generation of electrical energy has vastly improved the details of engine construction, especially in small sizes; it has also improved our knowledge of the laws of steam consumption at various loads, concerning which very little was known twenty years ago; and it was not until April, 1891, that this subject was elucidated by a gleam of genius which will probably continue to keep Mr. Willans's memory green long after his greater works are forgotten. It was during the discussion on Mr. Crompton's paper on the "Generation and Distribution of Electrical Energy," and after disappointment had been expressed by several speakers at the heavy consumption of coal in electricity works, that Mr. Willans propounded the now famous Willans law, confirmed by a complete series of experiments on throttle-governed engines.

In his own words, "with a fixed cut-off a certain quantity of steam was used to drive the engine doing no useful work, and, after that, each horse-power was obtained at a constant rate."

The most economical load is, therefore, the full load, and reduction of power by throttling increased the consumption per horse power, and to such an extent that Mr. Willans summed up the question thus: "The problem was not how best to reduce the power, but how to avoid reducing it." Yet, in spite of this, we are told that Mr. Willans leaned very strongly toward throttle-governing.

It is, of course, too much to expect that Mr. Willans would go out of his way to explain the merits of automatic expansion, since there had not, during his lifetime, been discovered any practicable method of applying automatic expansion to his engine; nevertheless the published results of the trials which he made with various grades of expansion, the cut-off being adjusted by hand, show clearly enough that a small high-speed engine of 40 h. p. could, if fitted with a really efficient automatic cut-off, give results which would entirely remove the objections to working at reduced power so ably exposed by Mr. Willans. The results referred to may be found complete in Vol. CXIV, part 4, of the "Proceedings of the Institute of Civil Engineers."

The speed of the engine tested was 400 revolutions per minute, and the size of the low-pressure cylinder was such that one pound of mean pressure gave 0.86 i. h. p. Therefore, in the following quotations, only mean pressures are reproduced, they being proportionate and nearly equivalent to the actual indicated horse power.

The effect of the increased ratio of expansion and the diminished power, as shown by diminished mean pressure, on the consumption of steam should be carefully noted.

Reference letter	M2.	E3.	O3.	Z3.
Steam chest pressure (absolute)	135.69	139.63	139.92	119.63
Mean pressure	46.89	31.67	25.23	18.72
Pounds of steam used per i. h. p. hour	16.72	15.18	14.98	15.51
Fraction of full load	1.00	0.675	0.54	0.4

The result of 15.51 pounds of steam under Z3 is probably rather too high in comparison with the others, as the boiler pressure was 20 pounds lower.

The most interesting feature of these results is that the highest degree of economy per indicated horse power is attained in the trial O3 at 0.54 of full load and with a mean pressure of 25.23 pounds, which pressure is nearly identical with the mean pressure employed in cotton-mill engines, which are sold by the degree of economy attained per i. h. p.

If it were practical to test the brake horse power of large engines, they could be sold by the economical result per brake horse power, and the best result could be attained only by the use of a higher mean pressure. The best illustration of this principle is afforded by the combination of an engine with a dynamo, in which the losses are known and made constant at all loads. Willans's experimental engine had an efficiency of 90 per cent. at 40 pounds mean pressure, and a good dynamo of corresponding capacity has an efficiency of 91 per cent. The combined efficiency is, therefore, 81.9 per cent. From this we deduce the mean pressure required to drive the diagram without external load thus:

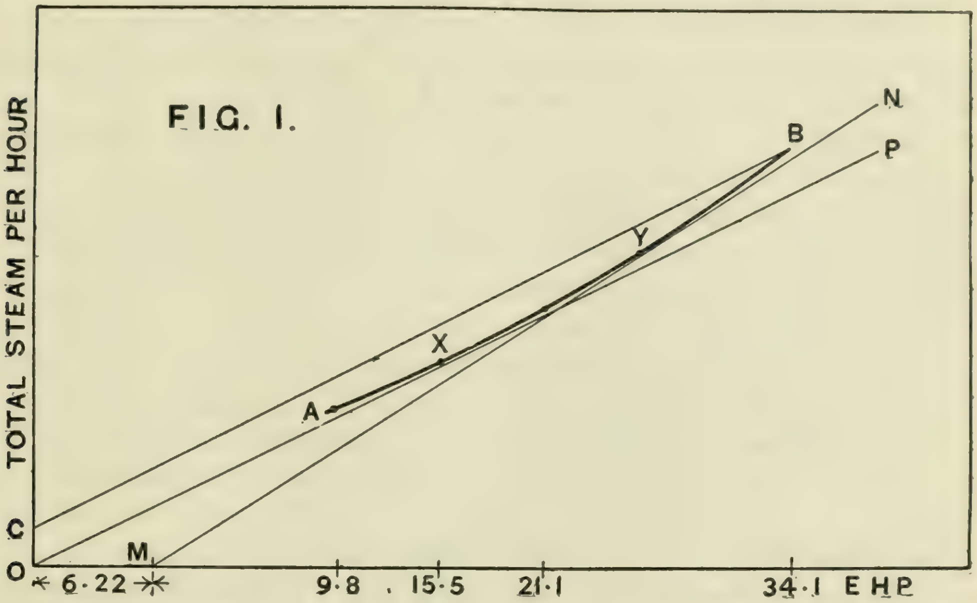
$$\text{M. P.} = 40 \times \frac{100 - 81.9}{100} = 7.24.$$

Introducing this datum into the results quoted above from the Willans experiment, we obtain the following figures:

Reference letter	M2	E3	O3	Z3
Steam pressure (abs)	135.69	139.63	139.92	119.63
Mean pressure	46.89	31.67	25.23	18.72
M. P. to drive dynamo	7.24	7.24	7.24	7.24
M. P. available as electrical horse power at terminals of dynamo	39.65	24.43	17.99	11.48
Steam per i. h. p. hour	16.72	15.18	14.98	15.51
Steam per e. h. p.	19.8	19.6	21.0	25.3
Net output per cent.	100.	61.3	45.25	28.9

These results are shown graphically in the following diagram, in which the net outputs in e. h. p. are marked on the base line, and the total steam consumption are ordinates to the curve A. B. The i. h. p. equals e. h. p. + 6.22, the power required to drive the dynamo without external load. The Willans straight line is shown at C. B.

FIG. I.



The line OP is drawn as a tangent to the curve AB; the point X, where it touches the curve, is the point of least consumption per i. h. p. The line M N is also a tangent to the curve A B, and its point of contact, Y, indicates the lowest consumption per e. h. p.

This diagram shows that reduction of power by automatic variation of expansion may be effected, not only without loss, but with a clear gain, down to 61 per cent.; and even as low as 45 per cent. the loss is not serious. On the other hand, they show that the makers of cotton-mill engines might raise their mean pressures with very great advantage to the purchaser, if the purchaser had sufficient knowledge to appreciate it. In the example O3 we have the highest economy of steam per i. h. p. at a mean pressure of 25.23 pounds, but in the example M2 we find the same engine giving more than double the *net* output with a smaller proportionate consumption of steam, but with a mean pressure of 46.89 pounds. A very strange feature of this question is that we find in one small country two centers of steam-power development, only two hundred miles apart and connected by telegraph and telephone, in which the experts of one profess to believe that the highest economy is to be attained between 40 and 50 pounds mean pressure, and those of the other believe that it is to be attained at about 25 pounds mean pressure. While electrical engineers are doing all they know to avoid low mean pressures, the Manchester school pays immense sums for the privilege of using them,—that is to say, they build a 1,000-h. p. engine and work it at six or seven hundred, in order to enjoy the satisfaction of imagining that the engine is economical; and they will continue to do so until buyers learn that there are more things in this world than are visible to the naked eye.

The mill owner or electrical engineer, either as the user or as the intending purchaser of an engine, will very naturally, at this point, ask the question: What is the teaching of the foregoing, as a rule for my guidance in choosing a system of governing; what is the most economical mean pressure to adopt? Unfortunately there is no short answer to that question; it is influenced by boiler pressure, by back pressure, by the mechanical efficiency of the engine, and by the character of the probable variations in load. It will, however, enable any one interested in the question to obtain an answer for himself, if he supplies the information on these points, and applies it by the aid of the following conclusions: Every first-class engine has a curve of steam consumption approximately similar to the curve A. B. (Fig. 1), and it will be observed that for a certain distance between X and B it is nearly coincident with the line M N. Within these limits of practical coincidence, the steam consumption per effective horse power does not vary sensibly; it is, therefore, of great importance to confine the ordinary variations in power between these points. For cotton-mill driving the most economical point should be chosen for the ordinary full load, but for electric traction a much lower point should be chosen, in order to provide a larger margin of power for emergencies. On the other hand, electric-light engines should carry the normal load at a very high mean pressure (even beyond the economical limit), so that a great reduction in power may be made without serious loss of efficiency.

It may not be possible for the steam-engine user to fix the ratio of expansion best for any particular case, or to dictate to engine builders the precise arrangements to be adopted to obtain the most economical mean pressure,—these are matters in which he will do best in all cases to appeal to the expert—but he will be able to decide for himself the policy most profitable to adopt.

THE GROWING IMPORTANCE OF CEMENT IN CONSTRUCTIVE WORK.

By Edward Wilkins Dewey.

THE past four years in the United States have been years of financial depression in every form of business. Factories have been forced to close, either from a lack of market for their goods, or from inability to compete in price with others who have preferred to keep in operation even at a loss. Although there has been considerable activity in government works and municipal improvements, railroad building has been at a standstill, and all private enterprises requiring capital have been waiting for a return of confidence, and it is not too much to say that nearly every manufacturer has felt keenly this state of affairs.

The manufacture of Portland cement has been one of the exceptions to this rule. The progress of this industry had long been retarded in the United States by lack of the knowledge and perfection attained by the European, together with the hesitation of capital necessary for an uncertain investment. When once it gained a foothold, it went forward with gigantic strides, and now is one of the great American industries. The product, under the most rigid tests, has proved equal, in every particular, to the leading brands of imported Portland cement, which it is rapidly superseding.

The annual reports of the United States geological survey estimate that the sixteen small factories in the United States in 1890 produced 335,500 barrels of Portland cement; in 1894 twenty-four factories produced 798,755 barrels; and in 1896 twenty-six factories produced 1,543,023 barrels; while an estimate for 1897 will not fall far short of the very respectable showing of thirty factories producing 2,304,000 barrels. This is the result of the more general use of Portland cement in all branches of building and engineering construction, the increased excellence of the domestic product, and the decrease in the price of the imported as well as the domestic article. With the return of prosperous times to which all indications point, the demand will be greatly increased, and will tax American manufacturers to their limit.

Until the last decade the use of Portland cement in the United States was considered a luxury by even the best engineers. The price ranged from $2.75 to $3.75 per barrel, delivered at the port of entry, to which was added the cost of transportation to its ultimate destination; if this happened to be west of the Mississippi river, the cost per barrel was frequently doubled, and in certain sections as much as $8.00 and $10.00 per barrel has been paid for it. The domestic cement was known as the hydraulic (natural rock) cement, and the little Portland cement that was manufactured was of a low standard, creating a prejudice which it has been extremely difficult to overcome.

In many sections of the United States are to be found inexhaustible deposits of limestone containing so much magnesia that it is unfit for the manufacture of Portland cement; but it is easily calcined and ground, and, in a neat test, it developed a tensile strength in seven days of 200 pounds, and in twenty-eight days of 300 pounds. Since 1880 this "Rosendale" or natural rock cement has been used in large quantities. In 1896 the United States produced and used 7,960,450 barrels, at a valuation of $4,049,202, or a trifle more than fifty cents per barrel, in bulk at the mill.

Germany produces annually about 13,500,000 barrels of Portland cement, exporting about 3,000,000 barrels, and consuming the remainder. It is estimated that the United States will consume in 1897 about 4,613,830 barrels of Portland cement, and about 8,000,000 barrels of natural rock cement,—a consumption nearly equal to that of Germany. In Germany the use of rock cement has practically ceased, as good Portland cement can be obtained at the works at $1.25 to $1.50 per barrel. In consequence of improved methods the cost of manufacturing in America is constantly diminishing, and, if the present fierce competition continues, German prices may soon be reached; then the Portland cement will gradually take the place of the rock cement, and drive it out of the market, as it has done in England and Germany. The excellence, however, of American natural rock cement, and the many ways in which it can be used advantageously, leads me to believe that it has obtained a firm foothold in the United States, which it will keep, regardless of the many predictions of the Portland cement adherents.

Although the apparent cheapness of the natural rock cement induced many American engineers and architects to specify Rosendale whenever practicable, they are now coming to the conclusion that, on account of the increased power of Portland cement for "taking sand," the latter is more economical at much greater cost; so that, in present construction, the practice of the best engineers is to give Portland cement the preference, whenever practicable. Hundreds of thousands of barrels of Portland cement form the concrete foundations of the huge office-buildings erected in the larger cities, while the brick and stone of the superstructure are laid in Portland cement, whereas in former years quicklime was used for the purpose, and, until recently, Rosendale cement. In all government works, such as concrete break-waters and light-house foundations, where the strongest cement is necessary on account of exposure to the elements and to the action of the sea-water, preference is given to the American Portland. It is believed that the day is not far distant when manufacturers in the United States will not only drive all the imported cement out of the market, but, by Yankee skill and enterprise, so reduce the cost of manufacture that they may even ship a surplus to Europe.

The duty imposed on cement by the McKinley bill in 1889 was eight cents per one hundred pounds which has remained unchanged through the Wilson and Dingley tariffs. During the recent tariff debate an effort was made by several cement manufacturers to increase the duty from thirty cents to fifty cents per barrel, arguing that the importation was 65 per cent. of the annual consumption, and that the infant industry needed further protection. This was opposed by several manufacturers, on the ground that, if there were a surplus, the United States could now sell their product in England at a profit. It was also stated that an increase in the duty would not be a benefit, as the competition among the American manufacturers is so strong that, on large contracts, the best grades of American Portland are offered at a price per barrel at least fifty cents lower than that demanded by foreign competitors.

The following table shows the number of works in the United States, and the relative production of the various sections:

Number of works and relative product of Portland cement at various localities in the United States, during the years 1890, 1894, and 1897.

UNITED STATES REPORTS.

	1890			1894			Estimated. 1897		
	Number of works	Product Barrels	Per Cent.	Number of works	Product Barrels	Per Cent.	Number of works	Product Barrels	Per Cent.
New York....	4	65,000	19.4	4	117,275	14.7	7	306,900	13.3
Lehigh County, Pa., & Phillipsburg, N.J.	5	201,000	60.0	7	485,329	61.2	8	1,520,300	66.0
Ohio.........	2	22,000	6.5	4	80,653	10.1	5	192,000	8.3
All other sect's.	5	47,500	14.1	9	115,500	14.0	10	285,100	12.4
Total.......	16	335,500	100.0	24	798,757	100.0	30	2,304,300	100.0

The district showing the greatest growth of the industry is in Lehigh county, Pennsylvania, where the factories have been enlarged again and again, until one company is producing about 2,800 barrels daily,—equal to 840,000 barrels per annum, or 36½ per cent. of the annual output estimated for 1897. Phillipsburg, New Jersey, also shows a gratifying development, and the two districts represent 66 per cent. of the entire production. The reason for this lies in the fact that there are found in that district enormous deposits of limestone nearly free from magnesia, and containing almost the correct proportion of clay, making a natural "raw mix" for Portland cement. It is not unlike the limestone found in Belgium, but more homogeneous. Before grinding, chemical analyses of the raw material are constantly being made, and such elements as are lacking in the various strata are supplied, to make a uniform product. The district is very accessible, and is traversed by two large trunk line railroads. The freight rate per barrel to New York is fourteen cents; to Chicago, forty-eight cents.

In many parts of the country there are, without question, limestone formations suitable for the manufacture of Portland cement, and these will be developed, in the course of time, yielding a large output.

The bulk of the Portland cement manufactured in the United States is made from argillaceous limestone; about one-fifth is made from "marl," or fresh-water chalk, formed from the decomposition of fresh-water shells. The following table shows the comparative product from limestone and marl:

UNITED STATES REPORT.

	1896.		1897.	(Estimated)
	No. of factories.	Barrels.	No. of factories.	Barrels.
Product from Limestone....	18	1,208,234	20	1,783,100
Product from Marl	8	334,789	10	521,200
	26	1,543,023	30	2,304,300

The marl deposits, as a rule, are usually confined to inaccessible tracts of low, marshy land of several hundred acres, not of sufficient magnitude to warrant the erection of large plants.

One of the most successful plants using the marl is in operation at Wayland, New York; its capacity will be doubled during the coming season. Intermittent vertical kilns are used, and the product is a heavy, slow-setting cement, not unlike the best brands of German cement. Several deposits are being worked successfully near Syracuse, New York. Various deposits of marl in Ohio and Michigan have recently been exploited, and it is stated that small plants will be erected before the end of 1897.

The largest deposit of marl known to the writer is at Montezuma, New York, about thirty miles west of Syracuse, on the Erie canal and New York Central Railroad, containing about 4,000 acres. The marl varies from one foot to thirty feet in depth; is almost white, containing about 85 per cent. carbonate of lime and 1 per cent. of magnesia; is free from grit and sand; and is, in every way, an excellent cement material, existing in practically inexhaustible quantities. Underlying the marl is a deposit of clay three feet in thickness. This tract of marl land is under option to New York capitalists, who propose to erect large works in the near future.

The United States is the only country where the rotary kiln is extensively used for burning the cement. The old-time vertical intermittent kiln and the modern Schofer continuous kiln have their adherents, but now the product from the rotary furnaces nearly equals that of the vertical kilns, as is shown by the following table :

	1896. Barrels.	1897 (Estimated.) Barrels
Rotary furnaces	632,370	1,059,265
Vertical kilns (continuous and intermittent)	910,653	1,245,035
Total	1,543,023	2,304,300
Per cent. of total product burned in rotary furnace.	41.0	48.0

The great increase in the use of the rotary kiln is in the Pennsylvania factories, where it is most successful ; the limestone makes a clinker at a lower temperature than is required with other limestones and marls. The rotary furnace has not been successful in burning the marls of New York State ; whether the marl, because it contains a large percentage of moisture, requires a greater temperature than can be had in a rotary furnace to obtain a clinker of sufficient density, or needs to be burned longer in a vertical furnace, is a question.

The limestones back of Rondout, New York, were too hard to be burned in a rotary furnace, and the plant erected there was a failure. So was a plant erected at Colton, California ; the limestone would not melt, until the owners looked over the files of the patent office and found a process (which they adopted) of adding to the "raw mix" about 3 per cent. of fluor-spar, which acted as a flux, and yielded as high a grade of Portland cement as was ever made in the United States. The city engineer of Los Angeles, California, gave it a year's test simultaneously with the best brands of imported cements, and in every particular the Colton cement was found superior.

The imports of Portland cement in 1896, as given by the United States bureau of statistics, were 2,989,597 barrels,—but a slight variation from the preceding year. But there is a marked decrease in the year 1897. The United States treasury department report the importation for the fiscal year ending June 30, 1897, as 2,348,020 barrels,—a decrease of 07.6 per cent. The amount of cement imported into the United States for the past six years has been very uniform, the total amount in 1896 being the same as in 1891. The following table shows the imports of cement into the United States for the fiscal years ending June 30, 1895, 1896, and 1897, by countries.

COUNTRY.	1895. Barrels.	1896 Barrels	1897. Barrels.
United Kingdom	806,884	742,169	460,592
Belgium	708,875	742,237	645,780
France	22,837	26,714	32,124
Germany	1,299,919	1,366,909	1,160,905
Other Europe	141,909	99,184	39,741
British North America	10,416	11,334	6,873
Other Countries	6,555	1,050	2,005
Total	2,997,395	2,989,597	2,348,020

An analysis of the above table shows many interesting points, the most striking being the constant decrease of the importation from the United Kingdom and the constant increase in the percentage of the German cements. The percentage of importation furnished by England in 1895 was 27; in 1896, 24; in 1897, 19. Germany, in 1895, supplied the United States with 43 per cent. of the total imports; in 1896, with 46 per cent.; in 1897, 49 per cent. It is not many years since their positions were reversed, but one need not search far to find the cause.

In spite of the fact that the English cement has been offered in the open market at fifteen cents a barrel less than the price asked for the best American brands, and seventy-five cents less than the price asked for the best grade of German cement, Germany continues to supply nearly half the amount of the cement imported into the United States, because the German manufacturers have advanced steadily in their methods and their product, leading the world to-day, as England led it twenty years ago. The English, on the other hand, are proverbial for their slowness in adopting new and advanced methods, which was never better exemplified than in the above instance. The New York agent of one of the large English manufacturers of Portland cement told the writer several years ago that he had begged his company to improve the quality of its cement. The management was highly incensed, and wrote in rebuke, saying that they had made cement for one hundred years, and it had always been considered the best that could be made, and, when such engineers as Sir———— and Sir ———— had used it and pronounced it good, it surely ought to be good enough for the American engineers, and, if they didn't want it, they could leave it alone. It reminds one of the story of the country-hotel proprietor who thus rebuked a criticising guest: "Say, stranger, you must be mighty particular; fifty men have used that towel, and you are the first one to find fault!"

The sharp note of alarm, however, was sounded in 1895 by the English authority, G. R. Redgrave, in the preface to his book, "Calcareous Cements," in which he says that he regards the present time as a very critical period in the history of the cement trade; that

England, the original seat of the manufacture, has been distanced in certain directions, in consequence of the superior scientific skill and energy of foreign rivals; and that nothing but the formation of a powerful confederation of cement-producers and cement-users, such as exists in many of the most enlightened countries, will extricate it from the present difficulties, or ward off times of even greater depression.

Although the percentage of imports of Belgian cements shows an increase during the past three years, it is not highly esteemed in America, being considered second-grade. The confederation of Belgian manufacturers, under the name of Hammer Societies, is making great efforts to extend the trade by offering their product at a lower price than that asked for other imported cements, as they can well afford to do. In Belgium there are large deposits of argillaceous limestone, not unlike those of Lehigh county, Pennsylvania; in composition it varies but slightly from the "raw mix" of Portland cement, containing clay and carbonate of lime, with a small amount of magnesia. It melts easily, and, by careful combination of different strata, may be burned directly into Portland cement, without preliminary treatment. It seems impossible, however, to keep it to a fixed standard, owing to the variations of its chemical composition.

Sweden, Denmark, and other districts included under the head of "Other Europe," show a marked decrease from 141,909 barrels in 1895 to 39,741 barrels in 1897. The Danish cement is highly esteemed on account of its excessive fineness, and every barrel can be sold at a premium. Eight hundred pounds were imported from Italy at a valuation of $3.00.

The principal ports of entry are New York, with a record of 1,036,000 barrels of cement in 1896, at a valuation of $1,350,114.00; San Francisco, 361,100 barrels; Baltimore, 341,000; New Orleans, 306,000; Boston, 258,490; twenty-six other ports, 436,000.

The American manufacturer has many advantages over his foreign rival as to price, quality being equal; not only must the duty of thirty cents per barrel be paid on imported cements, but they must be shipped in barrels, on account of the long ocean voyage. By shipping in bags, which are returnable, American manufacturers can reduce the price to the purchaser by an amount equal to the cost of the barrel,—twenty-five to thirty cents. The ocean freight varies considerably, depending on conditions; sometimes vessels pay for the privilege of carrying it as ballast, as it is very heavy and easy to handle; again, the freight on it is as high as thirty-five cents a barrel.

The relation of domestic production to importation has varied considerably, the imports remaining practically constant, and the domestic production increasing from 13.2 per cent. in 1891 to 49.9 per cent in 1897, as shown by the following table:

	1891. Barrels.	1893. Barrels.	1895. Barrels.	1896. Barrels.	1897. Barrels.
Production in the United States	454,813	590,652	990,324	1,543,023	2,304,300
Imports	2,988,313	2,674,149	2,997,395	2,989,597	2,348,020
Total	3,443,126	3,264,801	3,987,719	4,532,620	4,652,320
Exports	....	14,276	83,682	85,486	38,490*
Total consumption	3,443,126	3,250,525	3,904,087	4,447,134	4,613,830
Percentage of total consumption produced in the United States	13.2	18.2	25.3	34.7	49.9

* Returned under "Lime and Cement" prior to July, 1896.

This table shows that the percentage of the total consumption produced in the United States has increased 15.2 per cent. in 1897 over 1896, and that the exports have decreased from 85,486 barrels in 1896 to 38,490 barrels in 1897. The exports of Portland cement before 1897 were mixed with the exports of lime, so that the returns for 1897 are correct; previously the returns were incorrect. The total consumption in the United States shows an increase in seven years of 1,170,000 barrels, and an increase in domestic production of 1,849,487 barrels. This consumption of Portland cement will, no doubt, be greatly increased within the next few years.

The testing of cement has received increasing attention from engineers and engineering societies. The American Society of Civil Engineers has led in this movement; the rules for testing cements, adopted as standard by the committee appointed in 1885, were used extensively for a number of years, but, as the requirements increased, the specifications became more rigid, till it was voted by the society, at its annual meeting in January, 1897, to appoint a committee to draft a new set of resolutions, in conformity with the best practice here and abroad.

The highest requirements can be met without difficulty by most of the leading brands of domestic Portland cement. The rigid tests imposed by American engineers have resulted favorably to the cement manufacturers, having served to show the weakness of certain brands of imported cements, and the almost unexpected strength developed in the domestic article.

IRON-ORE LOADING ON THE AMERICAN GREAT LAKES.

By H. J. Slifer.

THE extreme industrial importance which, as Mr. Jeans ably shows elsewhere in this magazine, now attaches to supremacy in the iron trade, and the recent remarkable developments exhibiting the western continent, not only as sufficient to itself in iron production, but as a competitor in the markets of Europe for the sale of iron and steel in many stages of manufacture—these, and similar causes, lend a special value to the study of iron mining and metallurgy, and particularly to those methods of intensified production and labor-saving manipulation which are characteristically American, and which have given the United States a position far in advance of that which would be expected from the comparatively recent entry of the country upon iron making, or from the general impression as to its labor conditions.

These characteristics are evident in every stage, from the getting of the ore to the sale of the finished product. And beyond this the value of iron ; its necessity to mankind ; the many processes it undergoes for use in every department of economics,—make the study of it in its transition from a lump of ore to the hair-spring of a watch most interesting and instructive.

From the mine to the dock may then be termed the first stage of its journey ; let us begin it in the iron regions of Lake Superior.

Until the last two decades, Northern Wisconsin was considered a trackless wilderness, although for years a scientist, Increase A. Lapham, intimated that vast deposits of iron lay buried in the range that crosses the boundary line of Wisconsin and the northern peninsula of Michigan. It remained, however, for Nat Moore, a roving adventurer, to make the discovery that sent scores of prospectors to the region between Penokee gap and Lake Gogebic. His first trip was in 1872, but it was some years later that he found clean hematite, high-grade bessemer ore under the roots of a fallen tree. Then followed the great Gogebic boom, one of the most conspicuous episodes in the development of northern Wisconsin. The year 1886 found this at its height, and in May of that year it was estimated by a conservative newspaper that the value of the mines was $24,000,000. The railroads that hauled the ore to the lake became the best paying in the United States, and towns sprang up like mushrooms. Fortunes were

RECORD OF ORE DOCKS ON THE GREAT LAKES.

RAILWAY.	LOCATION.	DOCK NO.	LENGTH OF DOCK.	WIDTH OF DOCK.	HEIGHT OF DOCK. (Water to deck)	NUMBER OF POCKETS.	STORAGE CAPACITY, TONS.	HEIGHT. Water to Ctr. Hinge Hole.	LENGTH OF SPOUTS.	ANGLE OF POCKETS.
Chicago & North-Western Ry.	Ashland, Wis.	1	1404′	46′ 8″	54′ 0″	234	36,036	32′–10″	27′–0″	39° 30′
		2	1404	46 0	45 0	234	24,156	23 10	27 0	210 @ 42° 00 24 @ 45° 00
	Escanaba, Mich.	1	1104	37 0	48 6	184	24,104	28 10	21 0	39° 30
		2	1152	37 0	40 3	192	20,928	24 1	21 0	31° 26
		3	1356	37 0	52 8	226	30,284	31 2	27 0	45° 00
		4	1500	37 0	48 6	250	32,750	28 10	21 0	37° 53
		5	1392	37 0	53 3	232	43,152	28 6	21 8	40° 00
Duluth & Iron Range R. R.	Two Harbors, Minn.	1	1056	41 0	45 6	141	18,000	26 10	23 0	84 @ 37° 30 57 @ 32° 40
		2	1056	41 0	46 6	176	23,900	27 9	23 0	98 @ 37° 30 78 @ 32° 40
		3	540	49 0	51 6	90	16,000	28 10	23 0	38° 40
		4	1008	49 0	51 6	168	30,000	28 10	23 0	38° 40
		5	1008	49 0	54 0	168	33,000	30 0	25 0	38° 40
Duluth, Missabe & Northern Ry.	Duluth, Minn.	1	2336	52 0	53 0	384	57,600	30 0	27 9	45° 00
		2	1152	52 0	57 6	192	34,560	32 0	27 9	45° 00
Duluth, South Shore & Atlantic Ry.	Marquette, Mich.	1	1700	40 0	45 0	270	27,000	25 0		39° 00
		3	1200	53 6	37 0	213	12,780	23 0		
		4	1200	36 8	47 3	200	28,000	27 9	21 1	39° 45
Duluth, Superior & Western Ry.	Alloucz Bay,	1	600	49 8	52 0	100	15,000	29 9	26 0	43° 21
	Superior, Wis.		900	49 8	57 0	150	25,500	33 0	27 3	45° 00
Lake Superior & Ishpeming Ry.	Marquette, Mich.	1	1200	52 0	54 0	200	36,000	30 9	24 7	38° 45
Minneapolis, St. Paul & [illegible] Ste. Marie Ry.	Gladstone, Mich.	1	768	37 0	47 0	120	15,000	26 8	21 8	40° 00
Wisconsin Central Line	Ashland, Wis.	1	1908	36 0	54 6	314	33,500	31 4	27 0	234 @ 42° 30 80 @ 50° 45

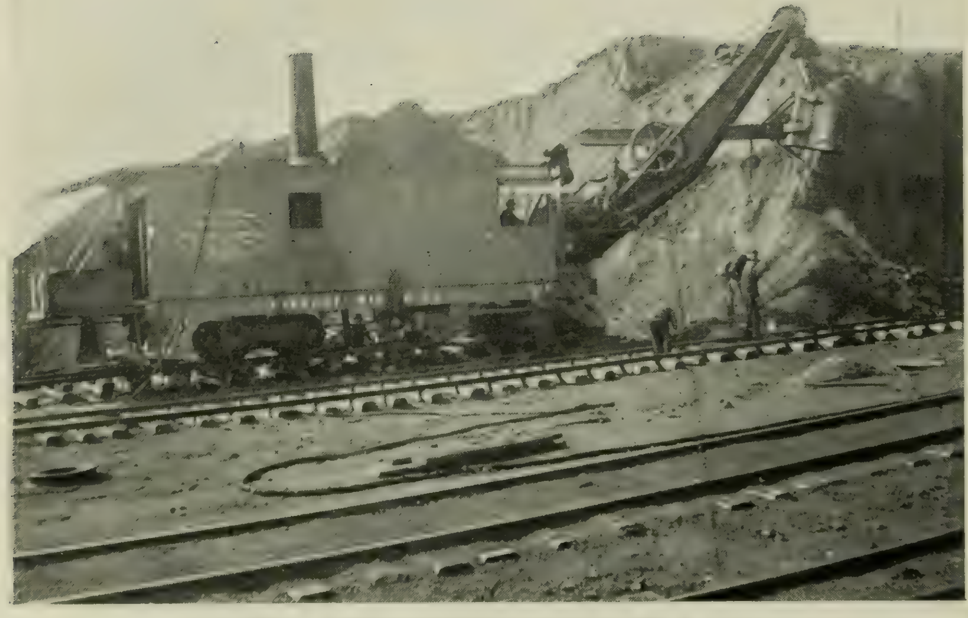
Compiled by Division Engineer, Ashland Division, C. & N.-W. Ry., Kaukauna, Wis., January, 1897.

A LINE OF SHAFTS AND STOCK PILE GROUND.

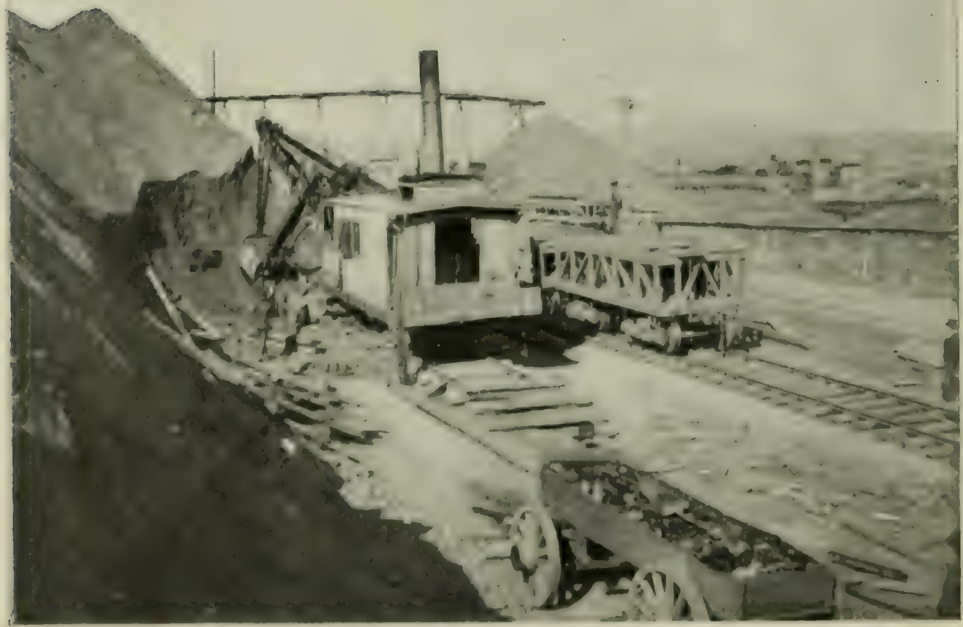
made while one slept, and the excitement was almost as great as that which accompanies the present exodus to the Alaskan gold fields.

Much might be written on the mining of the ore in the various

A STOCK PILE.



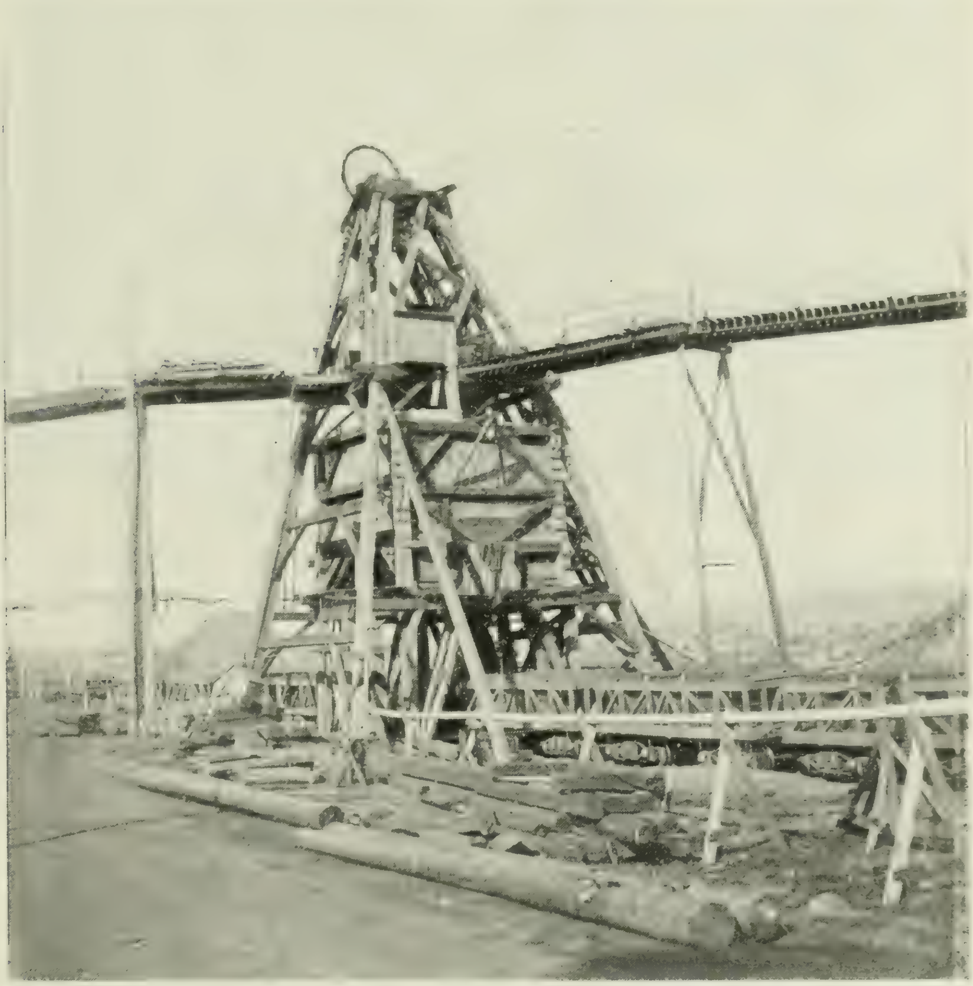
STEAM SHOVEL WORKING IN THE STOCK PILE.



LOADING ORE FROM THE STOCK PILE INTO CARS BY THE STEAM SHOVEL.

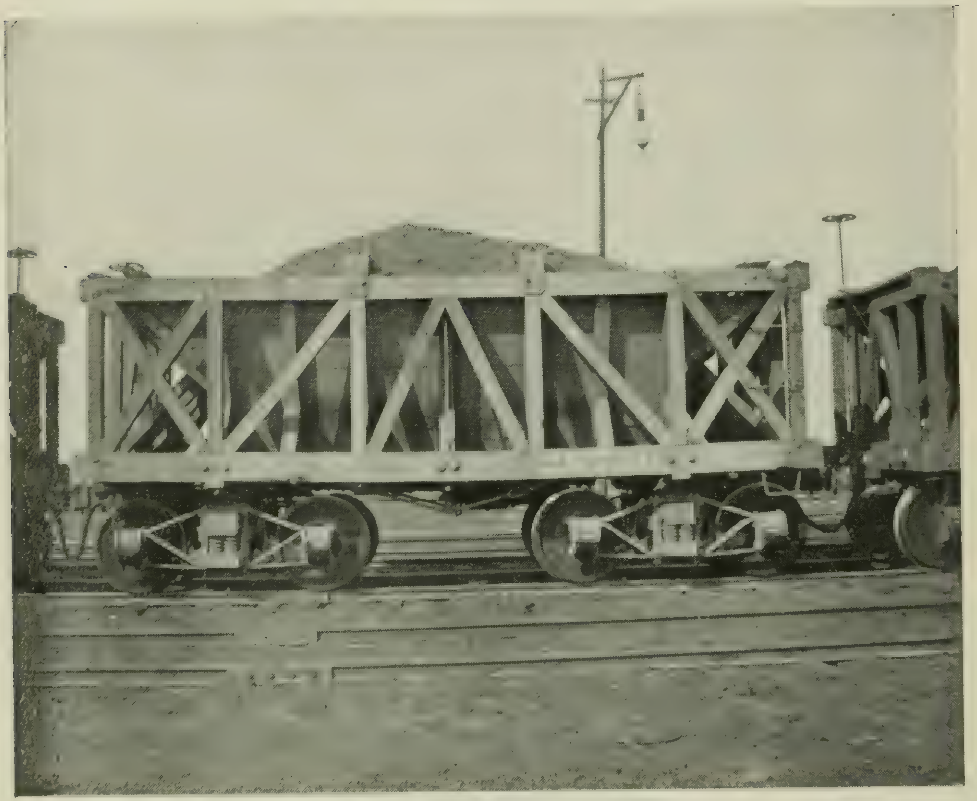
ranges, —the Marquette, Menominee, Gogebic, Penokee, Massabi, and Vermilion, each of which could be treated in an article by itself,—but it is the object of this paper to illustrate the methods in common use on the different ranges for handling the product of the mines.

That the quantity is enormous is evident when we consider that the Norrie mine alone has shipped in one season more than a million tons. The *Marine Review*, in a late issue, estimated that the total shipments for the present season will pass the ten-million mark, as up to September 1 there had been sent out 7,712,158 tons (gross). The bulk of the ore is mined in winter, when navigation on the lakes is closed, although some work is done the year round.



CARS BEING LOADED FROM POCKET AT THE SHAFT HOUSE.
THE OVERHEAD TRAMS LEAD TO STOCK AND WASTE PILES.

From deep shafts, some of which exceed 1,500 feet, the ore is raised to the surface, and stored in immense heaps, known as stock piles, being loaded into cars during the shipping season with the

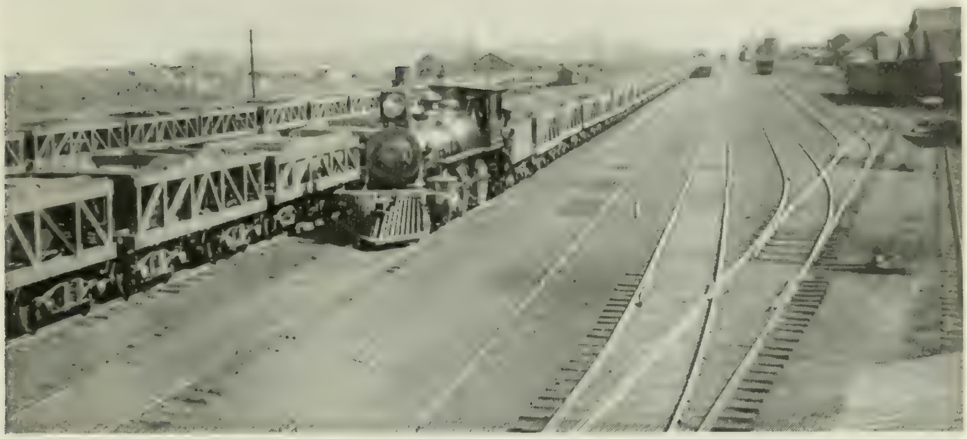


A "JUMBO" ORE CAR, LOADED.

ordinary steam-shovel. Many tons, however, are loaded from the shaft-houses directly to the ore-cars through pockets, with which the houses are all equipped.

Some of the mines produce as many as eight grades of ore, each of these being loaded separately and the separation being maintained through the various handlings. As the cars are loaded and tagged,

A LOADED ORE TRAIN EN ROUTE.

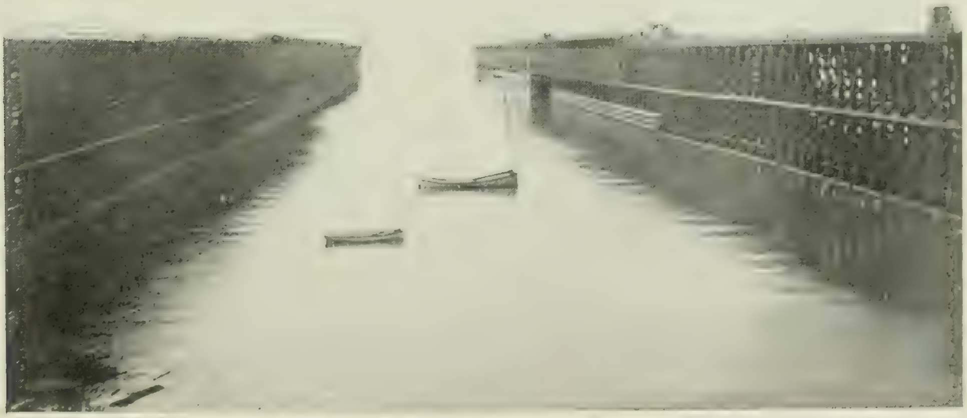


ORE TRAINS IN THE YARD AT IRONWOOD, MICHIGAN.

they are gathered up by switching engines, and taken to the yards, where they are made up into trains of from thirty-five to fifty cars. These are equipped with appliances for quick handling, as delay might prove costly.

Nature has assisted the railroads in transporting these loaded trains, the grade from the mines being a descent; from the Gogebic mine to Lake Superior the fall is one thousand feet.

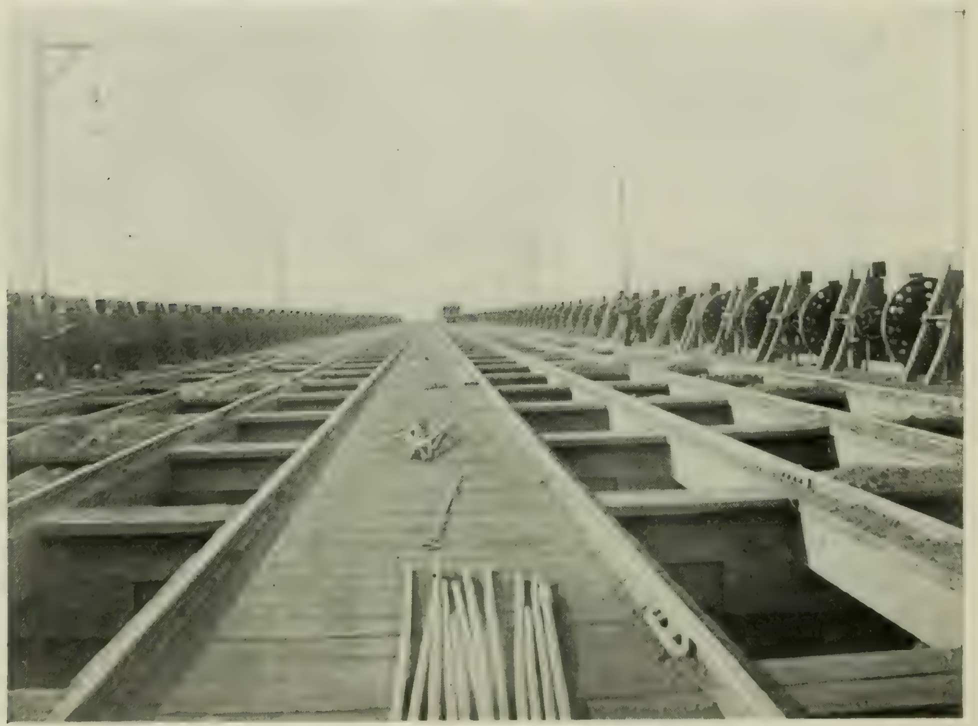
The details of transportation are in the hands of the vessel-owners



THE ASHLAND ORE DOCKS ON CHEQUAMEGON BAY, LAKE SUPERIOR, U. S. A.

and sales agents, who are in close touch with the superintendents of the several "docks," as they are generally, if rather loosely, termed.

On reaching the yards at the ore-docks, each car is carefully weighed, after which switching engines push the cars on the docks, and "spot" them over the pockets, the centers of which are spaced to fit the drop bottoms of the cars. The tracks over these pockets are so arranged as to allow the pocket to be "trimmed," by placing the car on the front or rear. The accompanying illustration of the top of a dock shows an arrangement which provides for three gages, with four rails, the center rails being used for gage on both sides.



THE TOP OF AN ORE DOCK, SHOWING TRACKS AND POCKETS.

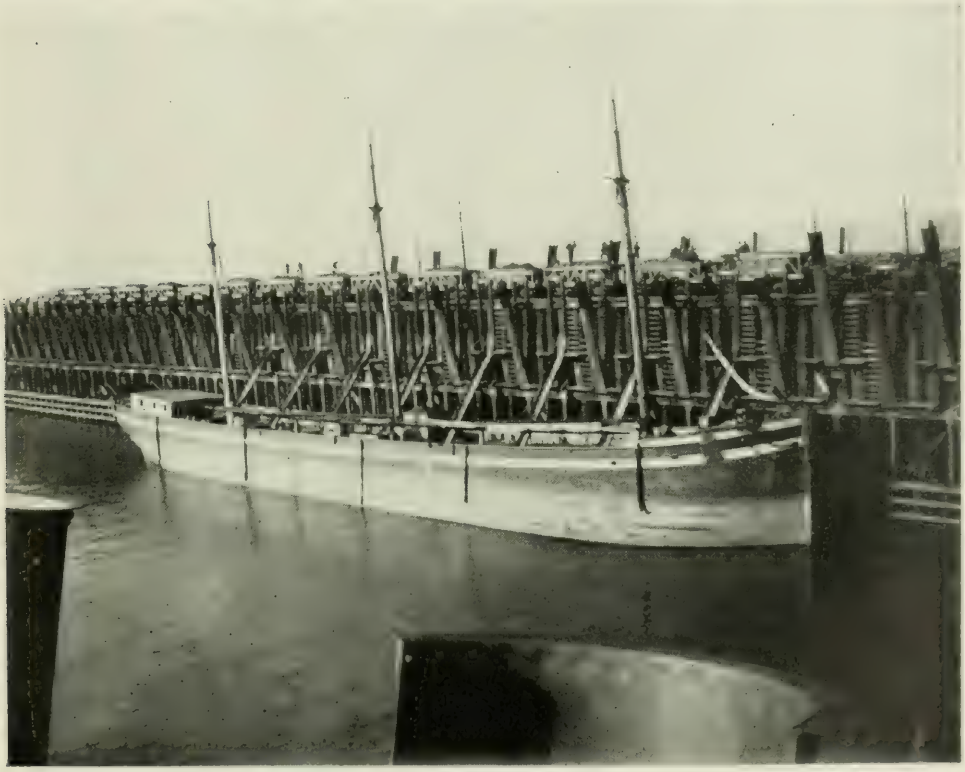
The ore is then dumped into the pockets, each of which will hold from four to six cars, weighing on an average twenty tons each. The writer has seen four Jumbo cars, holding, on an average, 104,000 pounds, gross, all on a wheel base of twenty-five feet. It can be seen, then, that the structures over which trains of this character pass, and on passenger-schedule time, must be kept in good condition.

The number of the car, its weight, the class of ore, and the number of the pocket are all put on record in the superintendent's office, and from these are made up the cargo of each vessel.

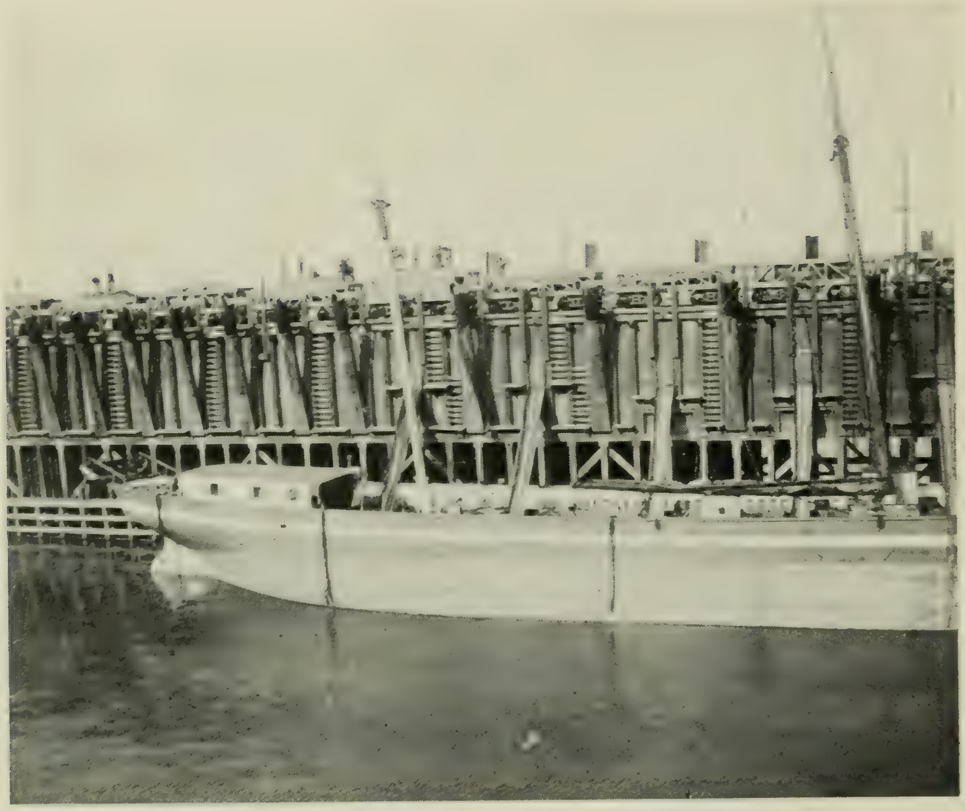
The general construction of the several docks on the Great Lakes is the same, there being some differences in the minor details of hoisting apparatus, counter-weighting, etc. Among the later docks built

VESSEL LOADING AT THE ASHLAND, WISCONSIN, ORE DOCK.

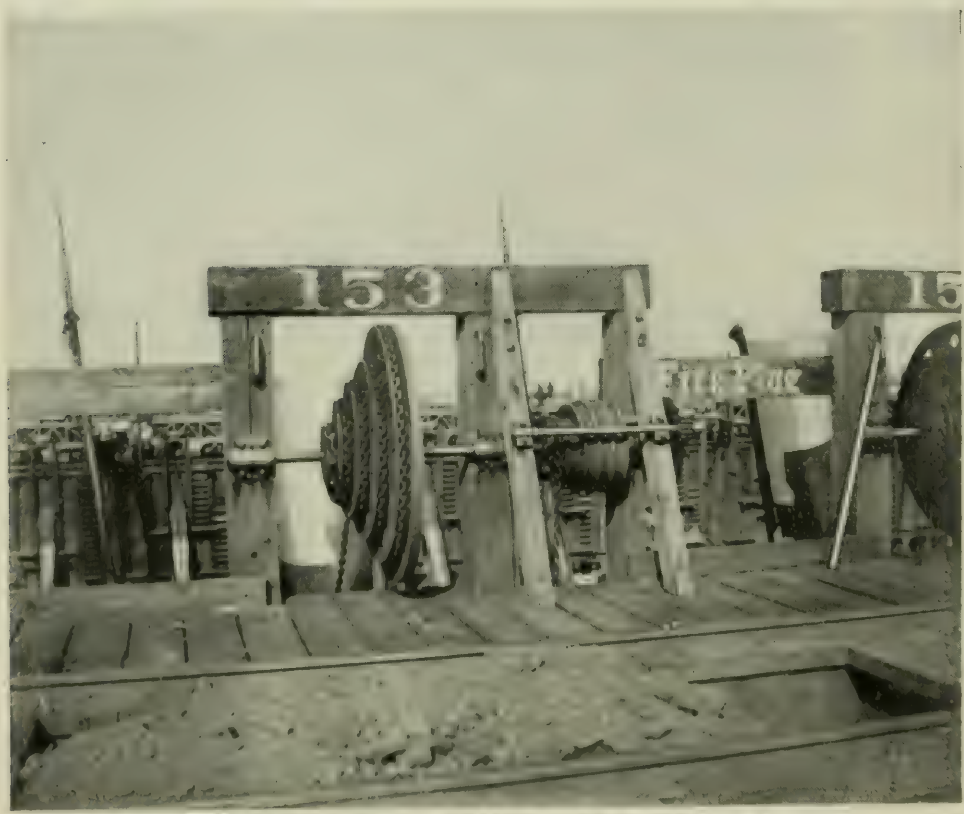
are those of the Chicago & Northwestern Railway Company, at Escanaba, in Ashland, rebuilt and remodelled under the direction of Chief Engineer John E. Blunt and Principal Assistant Engineer Edward C. Carter, by Division Engineers Palmer and Slifer; these



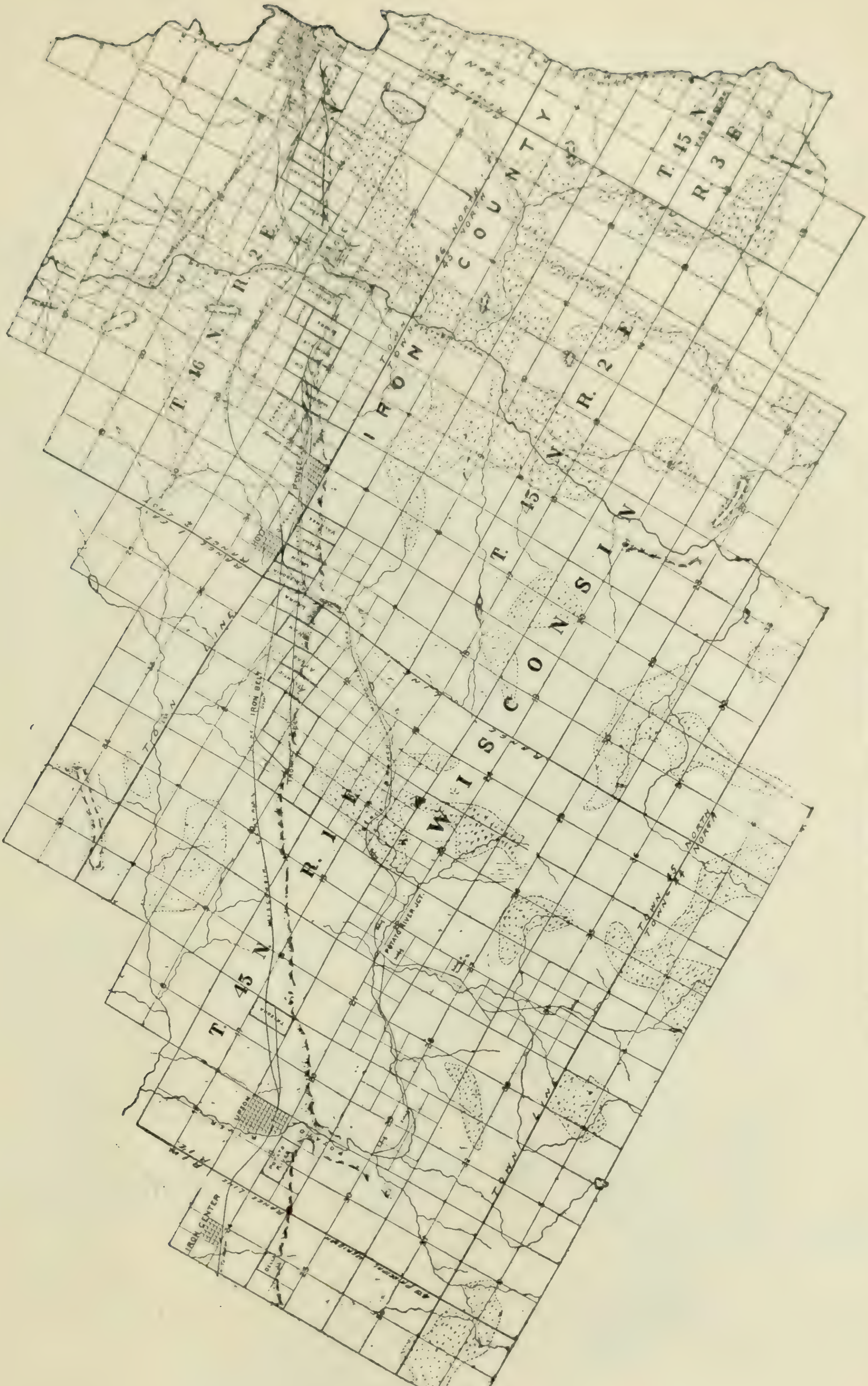
A VESSEL AT THE DOCK, LOADING FROM CARS THROUGH EIGHT SPOUTS AT ONCE.



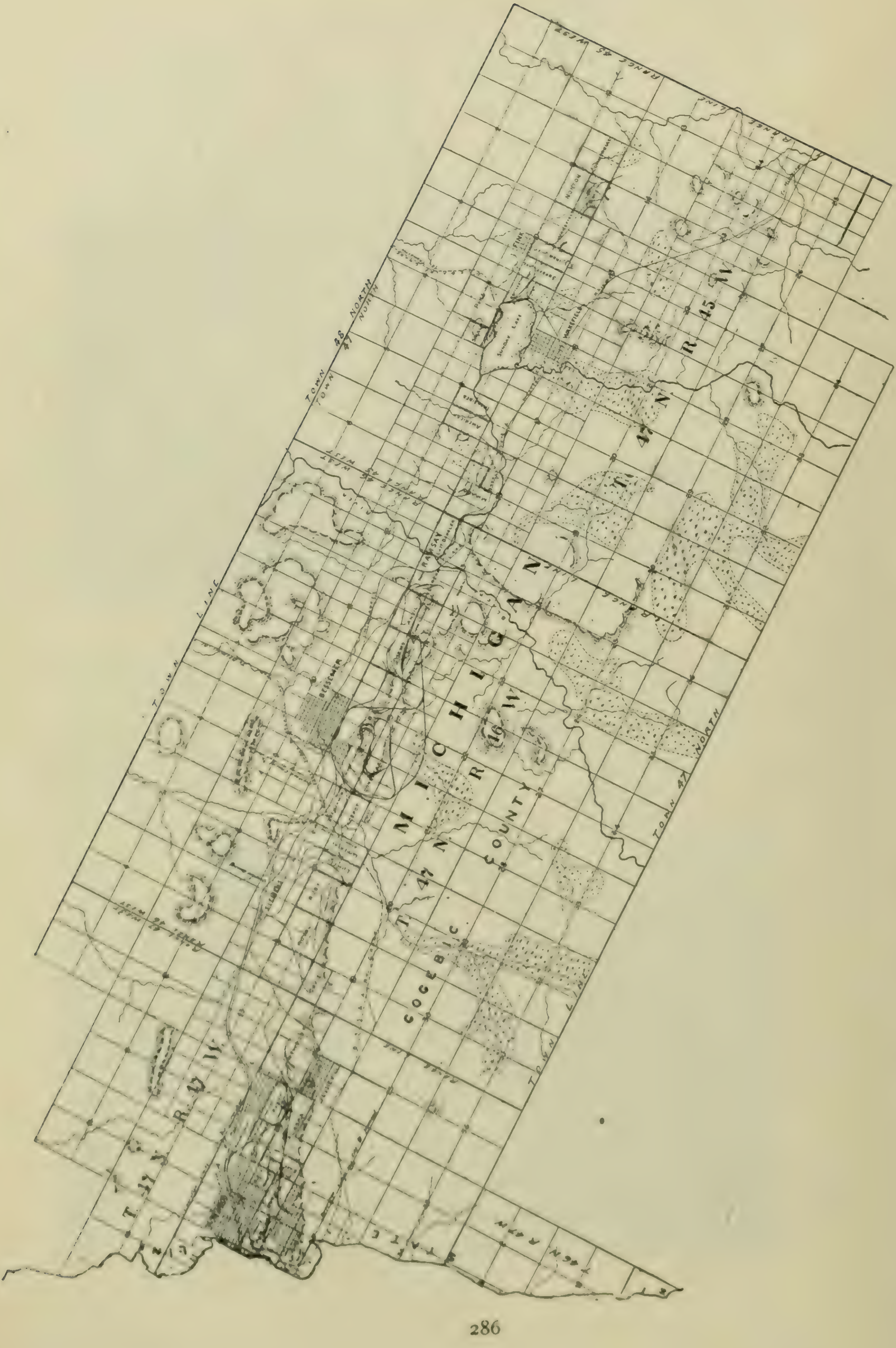
LOADING A VESSEL FROM CARS THROUGH THE POCKETS.



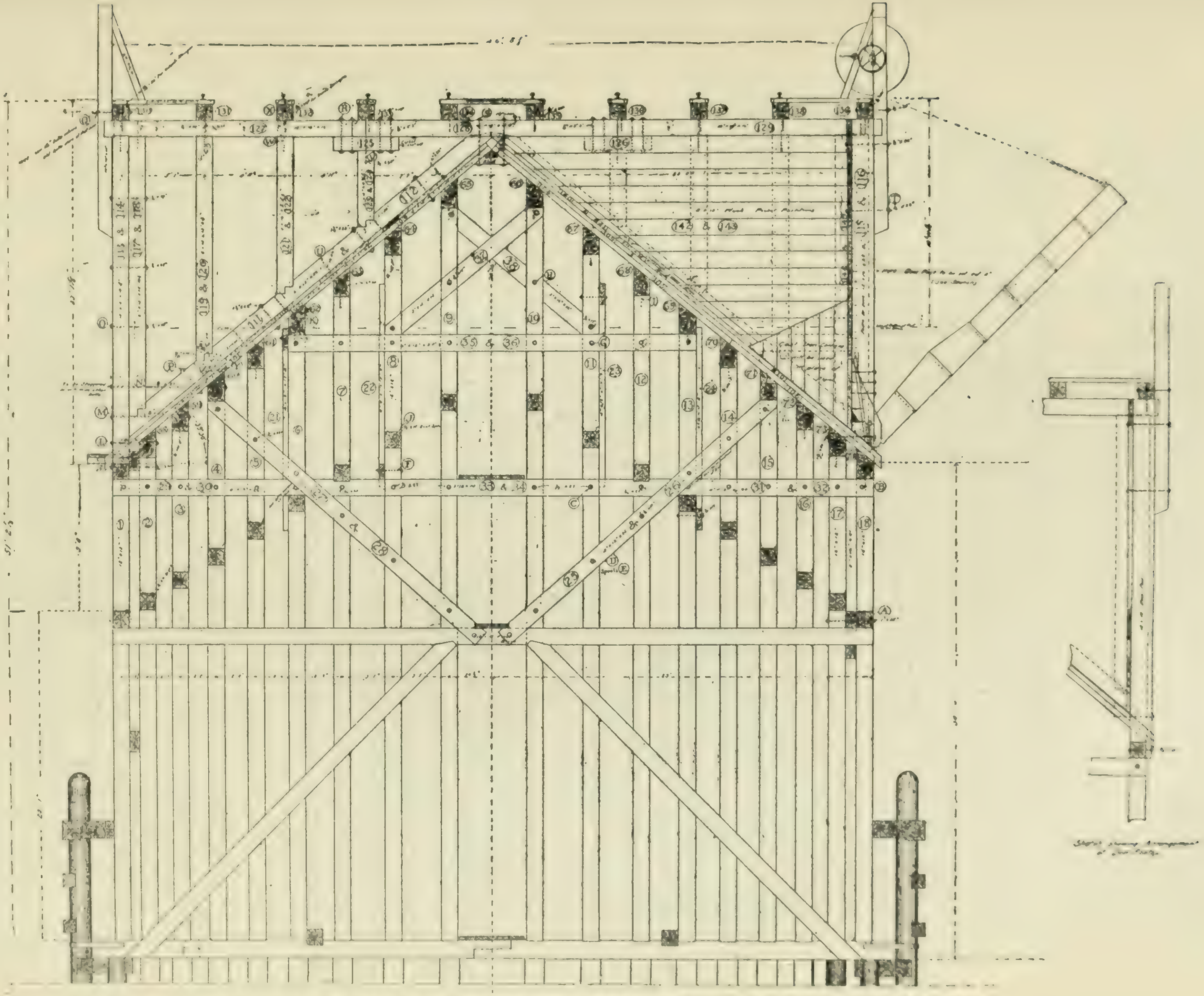
GEARING ON THE DOCK FOR RAISING AND LOWERING SPOUTS.



THE GOGEBIC IRON REGION. PORTION IN THE STATE OF WISCONSIN.



THE GOGEBIC IRON REGION. PORTION IN THE STATE OF MICHIGAN.



SECTION OF AN ORE DOCK, SHOWING ARRANGEMENT OF TRACKS AND POCKETS.

are shown in the "Record of Ore Docks on the Great Lakes" on page 276.

The docks consist of high, timber structures, supporting the tracks, from which the ore is emptied into the pockets, these being constructed with steel-clad sloping floors and maple corners, tending to carry the ore forward to the doors of the pockets, these being secured with large iron pins.

A boat, on reaching the dock, takes her place directly opposite the pockets from which her cargo is to be taken, and the spouts of such pockets as are to be opened are dropped into the hatchways, these being so constructed as to fit the docks, or, more properly speaking, the docks being built with pockets to fit the boats, twelve feet from center to center. The hoisting apparatus is made of steel, and is provided with counter-weights to assist in lowering and raising. Several appliances are in use for this purpose, but the same general principle is followed in every case,—a small cone wheel on the same shaft with the main gearing,—the only difference being in the location of the counter-weights and their construction. Some few of the older docks are not provided with the counter-weights, the spouts being raised and lowered by common gearing and main strength. Everything being ready, one of the laborers descends from the top of the dock to the platforms on a level with the door of the pocket, and removes the pin, when the ore is released, and transferred to the vessel. This method is sometimes varied by loading the boats directly from the cars through the pockets, as shown in the illustration. The "trimming" of the ore in the hold of the vessel is usually done by hand, but careful manipulation reduces this labor to a minimum.

A manifest is provided, and the ore then begins another stage of its journey, through the Great Lakes to some Lake Erie port, there to be reloaded into cars for its trip to the furnace.

ENGLISH GOODS STATIONS AND RAILWAY YARDS.

By Arch. R. Whitehead.

FOR some years after the first introduction of railways in England their owners did not work them, but were content to receive tolls for their use from any persons who cared to avail themselves of the facilities offered by the new and improved highways. Among others the coal-owners of Lancashire ran their coal along the railways in their own trucks, drawn by locomotives also belonging to themselves.

And for a considerable further period after the railway companies had found it desirable to undertake the conveyance, or haulage, of goods by their own servants and rolling-stock, they did not perform the services connected with their receipt and dispatch. They neither collected, delivered, loaded, or unloaded the goods entrusted to them for conveyance. These duties were left to the general carriers who had hitherto performed similar duties in connection with their business on the high roads and canals. And it was with these carriers that the public and traders dealt, and not directly with the railway companies, as at present.

The railway companies erected sheds in the large towns (or usually just outside them) for the purpose of loading and unloading, under cover, the trucks of merchandise brought to them. There were one or two short sidings laid down in front of the sheds, with a turntable and siding running into the shed. These were let to the carriers at an annual rent; in some cases, however, the sheds were erected by the carriers themselves on their own property purchased alongside the railway.

It was to these sheds that all goods to be forwarded were brought. The carriers weighed the goods, invoiced them, loaded the trucks, sheeted them, and handed them over, at the doors of the shed, to the railway company for conveyance or haulage. On the arrival of the trucks at their destination the railway companies transferred them to the carrier at the door of his shed, and the unloading, carting, and delivery were then performed entirely by the carrier.

This description refers only to the larger towns. At this time there was very little goods traffic of any kind at the roadside stations, and, in consequence, no sheds were erected at those places. Here only full truck loads, such as coal or agricultural produce, could be received, and these were entirely loaded and unloaded in the open yard, by the consignors and consignees of the goods.

Miscellaneous consignments of ordinary merchandise belonging to, or to be sent to, different persons could not be dealt with at these roadside stations, there to be loaded together in one truck. It is obvious that much difficulty and loss would necessarily ensue, if the public were allowed free access to such trucks for the purpose of loading and unloading.

At the larger towns any full truck-loads were run into the sidings in the open yard, and there unloaded by the consignee. They were not brought into the carrier's shed.

Thus, in those days, what is called the "carted," or "shed," traffic was entirely in the hands of the general carriers, while all the work at the stations in connection with "station to station," or "yard," traffic was performed by the consignors or consignees themselves. The railway companies provided nothing more than the railway line, yard, and sidings, with the locomotive power and trucks; with that their duties ceased. They themselves undertook for the public nothing in the way of "terminal station service," as it is now called, and of course, as they had no warehouses, they could not warehouse any goods.

All this, however, is now changed. The public deal directly with the railway companies, who perform the whole of the services above described as being at one time undertaken by the general carriers.

That the change has been an advantageous one is indicated by a recent report by the board of trade, which, after a long and most exhaustive inquiry, stated that "we do not think it wise to encourage a system by which truck-loads of miscellaneous goods would be collected from several traders for delivery to the railway company."

An attempt will now be made to describe the manner in which goods traffic is dealt with by the railway companies at present.

The coal traffic should perhaps first be taken. It is by far the largest item in the class of "minerals," which contributed 72 per cent. of the tonnage conveyed in 1895 over the whole of the railways in the United Kingdom, there having been 240,250,000 tons of minerals carried in that year against 94,000,000 tons of general merchandise.

Coal is still always unloaded by the consignee, and is very often carried in owners' wagons. The accommodation usually provided consists of one or more sidings, each with a metalled roadway some thirty feet in width, running parallel alongside, to allow carts to draw up to the trucks in the sidings. There is also provided a strip of ground alongside the siding for the purpose of stacking the coal. As this is frequently traversed by carts, it is sometimes metalled or paved.

At some places coal drops are provided, and, where there is a large traffic, the sidings and carting spaces alongside are roofed over. The railway company's charges vary with the extent of the accommodation afforded. The coal merchants themselves erect at the smaller stations small timber offices for the use of their clerks, generally near the entrance to the yard, but at the larger stations more permanent offices are built. A weighbridge, for weighing carts, is always provided, and is placed at the entrance to the yard.

Sidings for coal, and indeed all sidings intended for trucks to be unloaded by the public or traders, are generally "dead-ended," and are laid down on a site quite clear of any shunting lines. When they are long, they are planned to allow of the removal and replacing of trucks, when unloaded, with the least possible disturbance of adjacent trucks, so that loading operations going on around may not be interfered with.

For bricks, stone, and building materials the accommodation given is similar to that for coal. For dealing with this traffic many traders rent from the railway company a small piece of the yard, on which to erect lock-up sheds for their own special use.

For potatoes, vegetables, and fruit, at some of the more densely-populated centers, sheds are provided in which traders may themselves, under cover, unload their produce on to platforms raised to the level of the floor of trucks, and accessible to carts and vans.

And, wherever the fish traffic is sufficiently important, very similar accommodation is provided. But for obvious reasons this department is not allowed to be too obtrusive; on the other hand, it must be easily accessible. And, as with fruit and all "perishables," the loading and unloading must be capable of accomplishment in the shortest possible time. Small consignments of fish are conveyed by passenger trains.

For live stock, even the smallest roadside station has a short dead-ended siding, with a loading wharf alongside (raised to level of floor of truck) having easy approaches. One or two cattle-pens are erected on the wharf, and a carriage landing dock is formed at the end. Horses and carriages being often conveyed by passenger-trains, this accommodation is located near the passenger station. The cattle-pens are paved, well-drained, and supplied with water.

In all but the smallest stations there is a crane for the purpose of lifting heavy weights from the trucks directly into carts, or *vice versa.* It is usually constructed to lift five tons, and is worked by hand-power.

The general merchandise, which, as before mentioned, comprises but 28 per cent. of the total goods traffic of the United Kingdom, is dealt with in goods sheds, and is known as "carted" or "shed," traffic.

It is loaded and unloaded by the railway companies, which also, either by themselves or by their carting agents, perform very much of the carting in connection with it.

The bulk of this traffic is carried on at the large towns. As an instance of this, the case of the London & North Western Railway may be taken. This company has some 1,900 miles of line, which is from one-eighth to one-seventh of the total mileage in England and Wales. There are some six hundred goods stations on this company's system, but very nearly, if not quite, one-half of the general merchandise carried by the company is carried on in four towns, —London, Liverpool, Manchester, and Birmingham. These towns contain some five and three quarter millions of inhabitants, or about one-fifth of the population of England and Wales.

No doubt for economical reasons, the goods stations were originally located in the suburbs or outskirts of the large towns. But during the past twenty or twenty-five years, for the purpose of saving time and expense in carting, and in order to deal properly with the increased traffic, it has been found necessary to incur enormous expenditure in the provision of goods stations situated nearer to the business centers of the towns.

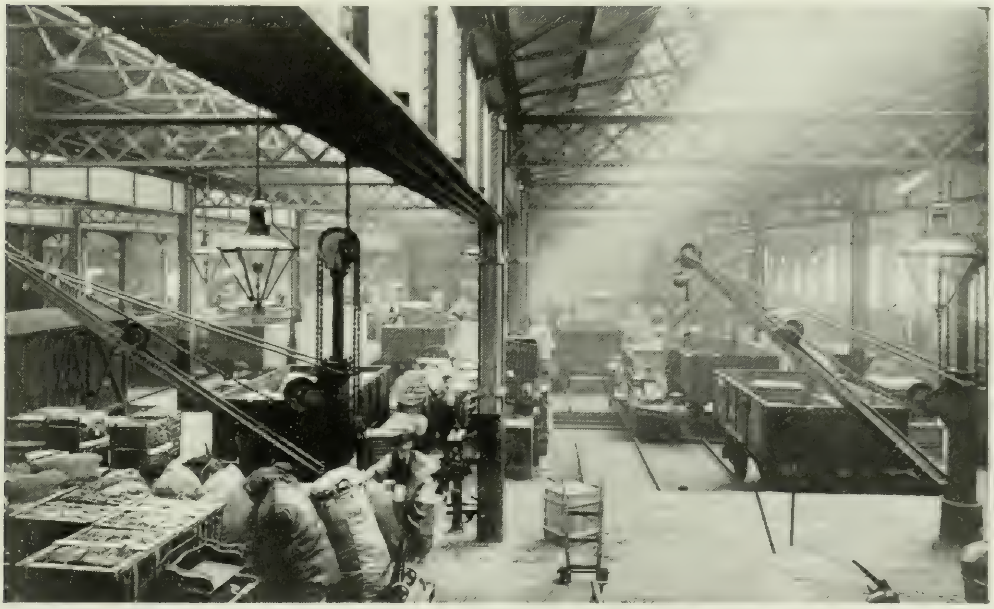
Besides this, numerous receiving houses and enquiry offices have been established in every business neighborhood. To these receiving houses (which are frequently shops erected for ordinary business purposes, but with some necessary alterations in the fittings) parcels and small goods (generally of less than five hundred pounds) are sent by the traders. These receiving houses are of very great use to the public, bringing the railway service to the door of the trader, and are most valuable adjuncts to the goods stations. They enable the railway carts, when they have finished the delivery of goods sent from the goods station, to pick up a full load for their return journey, instead of going back empty, or with only a few packages picked up from door to door.

In the recently-erected central goods stations, owing to the costliness of the sites, it has been necessary to use to the greatest advantage every square foot of the area, at the same time avoiding the mistake of cramping the working-spaces.

Hence we find that in many instances there are, over a large portion of the area, two railway yards, one carried some twenty or twenty-five feet over the other by steel or cast-iron stanchions and rivetted girders. Wherever the nature of the site permits, there are easy cart approaches to each level.

In many of the earlier examples, goods stations were constructed in brick vaults under passenger-stations. These are necessarily cramped, inconvenient, and dark. Turntables in such cases cannot be dispensed with, and consequently the access by trucks, as well as by carts, is a slow process.

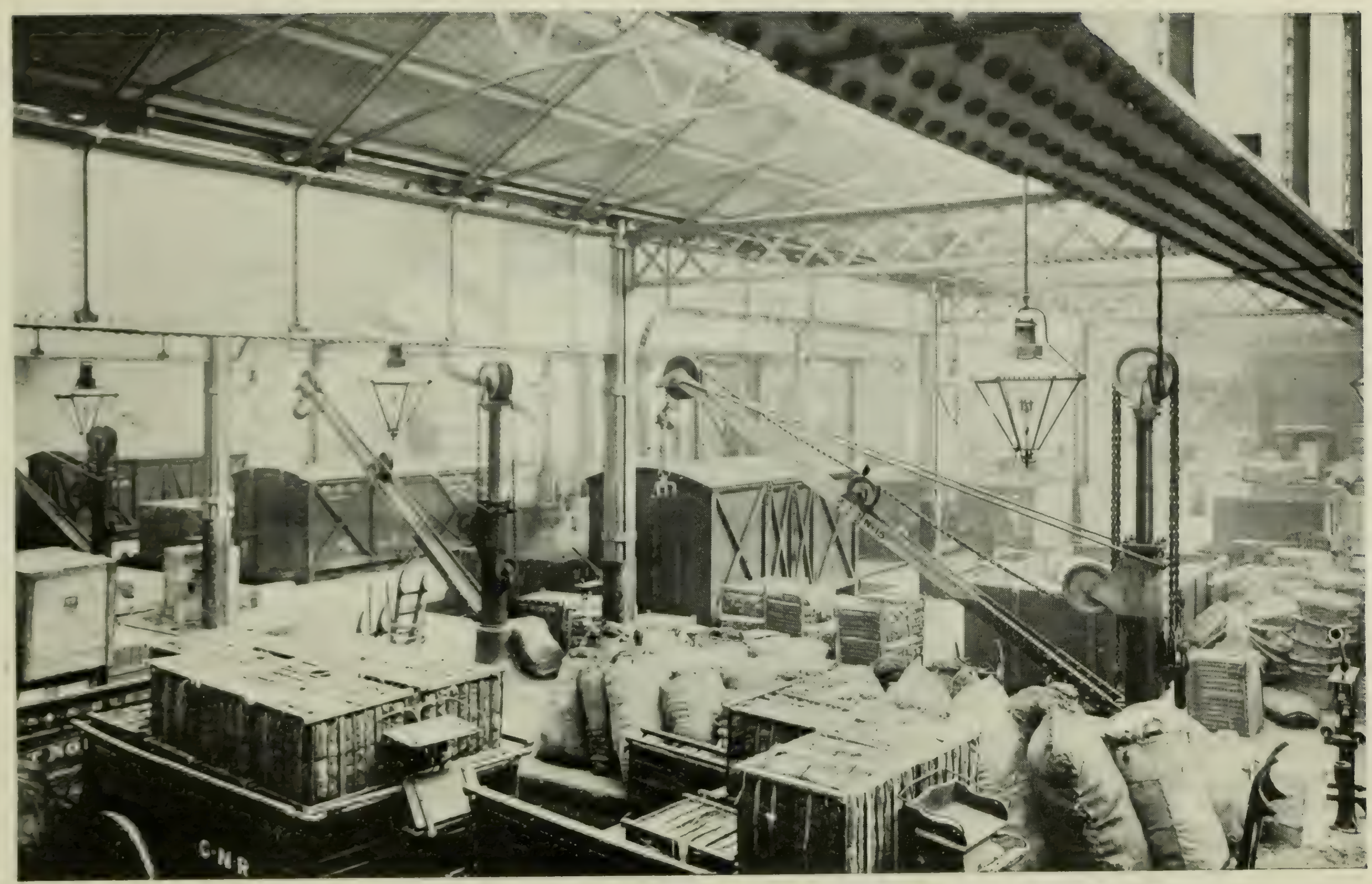
But to return to the newer type. Usually the sites are so confined that one level only is accessible by locomotives. Hence hydraulic hoists are used to raise and lower the railway trucks to the other level. The tables of these hoists are about twenty-three or twenty-four feet in length, sufficiently long to take any trucks in ordinary use in England. These hoists are calculated to raise about twenty tons. The trucks in ordinary use weigh from four to five tons, and have a maximum capacity of ten tons.



GREAT NORTHERN RAILWAY COMPANY'S DEPOT AT FARRINGDON ST., LONDON.
UPPER OR STREET LEVEL.

The warehouse proper is erected in some convenient position. It has two or more floors above the higher rail-level. These warehouses are plain, substantially-built structures, with brick walls, cast-iron or rivetted-steel stancheons, and fire-proof floors. They are furnished with hydraulic hoists communicating, in the interior, with the platforms or cartways at the rail-levels, and, on the exterior, with any cartways provided.

The loading decks or platforms alongside the sidings are located immediately beneath the warehouse, so that they may be in direct communication by means of hydraulic hoists, although their chief use is as working platforms for general goods.



UPPER LEVEL OF THE GREAT NORTHERN RAILWAY COMPANY'S FARRINGDON STREET DEPOT, LONDON.

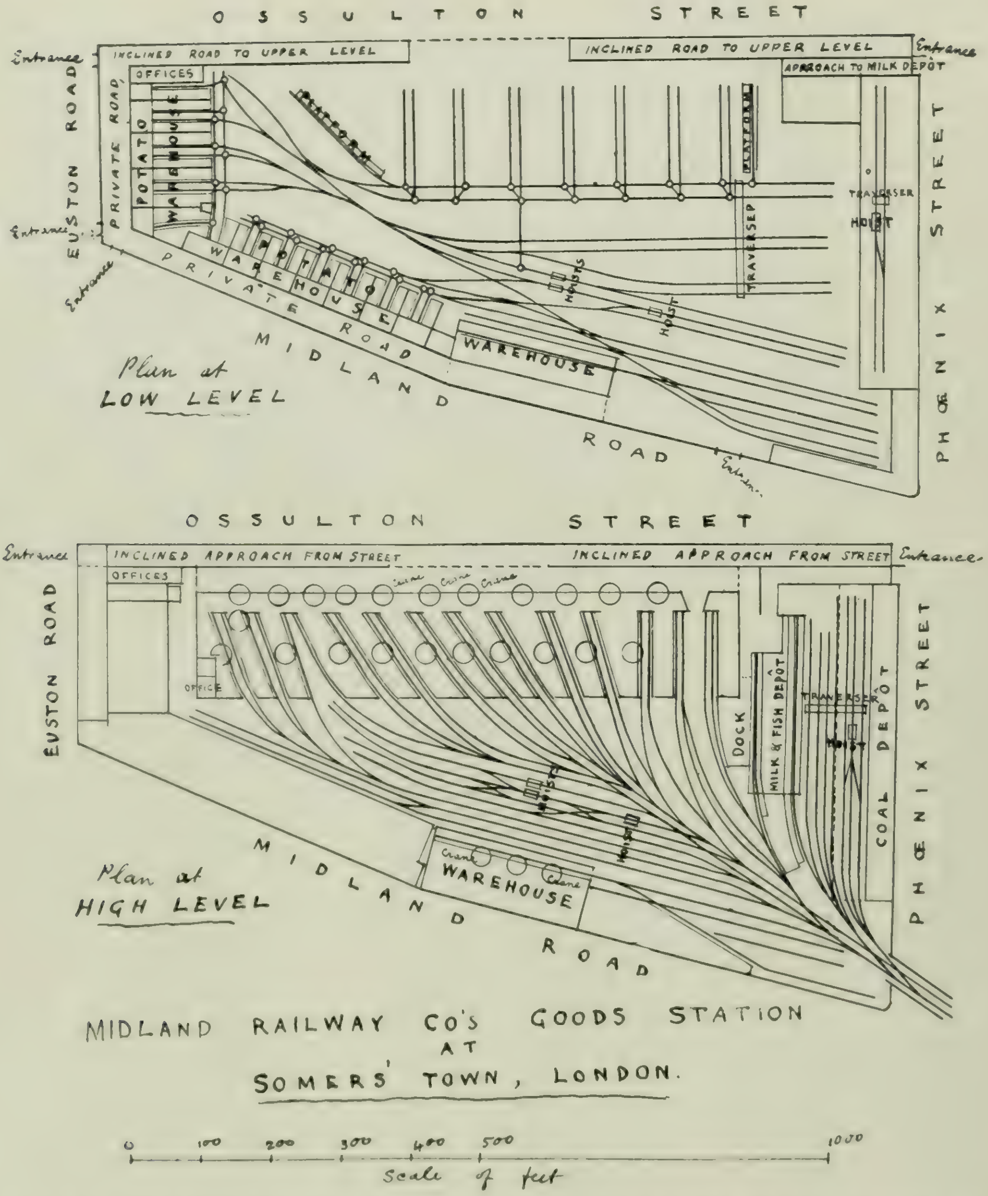
Being two miles nearer the heart of the city, and consequently upon land of very high value, this is naturally on a smaller scale than the Somers Town station, illustrated on pages 295–297.

SOMERS TOWN GOODS WAREHOUSE, MIDLAND RAILWAY, LONDON.

They are commonly about twenty-four feet in width, and have a cartroad, from thirty to forty feet wide, running alongside, opposite the siding. Cranes are fixed along the center of the platforms.

But in some recent examples a series of short platforms (each from 120 to 160 feet long,—*i. e.*, for six to eight trucks) are placed in parallel lines, with a pair of sidings alongside each. The ends of these sidings and short platforms abut on to a longer and wider end platform, to which the carts are brought and backed. Cranes are

COAL PLATFORM OF THE SOMERS TOWN STATION, SHOWING HYDRAULIC HOIST.



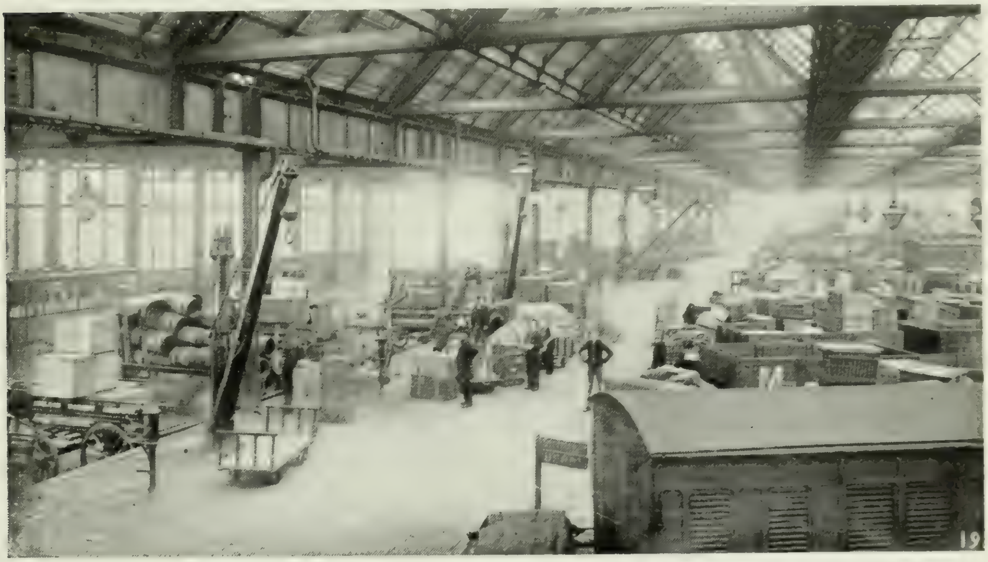
MIDLAND RAILWAY CO'S GOODS STATION AT SOMERS' TOWN, LONDON.

fixed in the center of each short platform and along the outer edge of the end platform.

The end platform should be thirty feet in width, and the shorter platforms twenty feet. The cartroads should be forty feet wide, to allow of two carts passing in front of those backed against the edge of platform. The platforms are from 3½ to 4 feet in height above rails. The sidings in these central goods stations are very carefully laid out, so as to enable trucks to be brought into their places quickly. Wherever possible, in order that the whole of the shunting may be performed by locomotives, nothing but ordinary turnouts are used for connecting the sidings, but this is impracticable in very confined sites, and turntables, traversers, and capstan-working have to be fallen back upon.

Where there are two levels of rails (upper and lower working floors), those goods which require the greater dispatch are handled at the ordinary level of the railway, and those only of the trucks which contain the less urgent consignments are sent to the hoist. Goods not intended for delivery on arrival (or "wait order" consignments) are lifted to one of the warehouse floors, and there deposited. These goods are allowed to remain there for about a month without payment, but after that period a small charge is made for warehousing.

Hydraulic capstans, cranes, and hoists are largely used, and sometimes traversers are worked by hydraulic power, but, beyond this, few mechanical labor-saving appliances—such as conveyors—are used in these stations.



LOADING PLATFORM IN THE SOMERS TOWN STATION.

90 to 100 carts can be backed against the long main platform, and about 180 trucks can be accommodated in the 26 sidings alongside the branch platforms. Weighing machines are placed on the platform in each bay.

The diagram plans on the opposite page show the general arrangement of the low and high level floors of the Midland Railway Company's goods station at Somers Town, London.

This station—which adjoins the St. Pancras passenger terminus—occupies an area of about fifteen acres. It has been built about five years, and is an excellent example of the latest English practice. It will be noticed that on the high level there is direct connection by locomotive to every siding, no turn-table—or capstan and hawser—being required for placing the trucks in their berths.

AN ENGLISH "ROADSIDE STATION." STATION BUILDINGS AND ENTRANCE TO GOODS YARD.

The station master's dwelling is in the upper storey. In more modern examples it is in a wholly detached building.

The clear height of the shed is 25 feet. The columns supporting the roof are spaced at a distance of 35 feet apart, so as but very slightly to obstruct the working space. The greater number of the hydraulic cranes fixed on the platforms will lift 30 cwt. ; some few will lift 40 cwt. At this station, separate invoices are given for the contents of each truck ; and for the quick conveyance of the consignment notes from the truck side to the invoice office there is a "ball railway," similar to those frequently used in large retail shops, but introduced into railway sheds for the first time at this place.

At one end of the shed there is a raised platform for carts, running alongside and at a level of about 4 feet above the rails of siding. This is to enable carts to be backed up to the trucks and discharge their goods over the top of the sides of the trucks, without lifting the goods above the level of the floor of the cart.

In other parts of the yard full cart-loads can be brought at the level of rails to the truck side, without the intervention of a platform.

As will be seen from the views, the shed is admirably lighted by day. At night it is electrically lighted so that work then can be carried on as expeditiously and as safely as by day.

Every cart on arrival at the station is taken on to a weighbridge at the entrance to the shed. Frequently as many as 200 carts are weighed during one hour.

In this shed miscellaneous goods are unloaded, checked, weighed, distributed, loaded and dispatched at the rate of 150 tons per hour; allowing for relays of wagons, and of staff, the full capacity is estimated at 2000 tons in 24 hours; but it is only during three or four hours in the late afternoon of each day that the shed is worked to its full capacity.

There is, of course, no space available at these central stations for the sidings necessary in order to arrange and sort the outgoing trucks in proper train order. This work is done in the sorting and marshalling yards, which are a few miles outside the towns.

To these yards are brought all the trucks from and to the various local stations. A train, on arrival at the entrance to the sorting sidings, is turned into one of a group of parallel reception sidings. Here the engine is detached, and the wagons are uncoupled and put by a shunting engine into one or other of a series of sorting sidings, according to destination. Sometimes a second series of sorting sidings is laid in for the purpose of further sorting the trucks (already put into train order) in proper station order. The trucks, being thus arranged in the proper train and station order, are then ready to be taken to their destinations.

Separate sorting sidings are laid in for "arrivals" and for "departures." If the gradients of the railway, and the contour of the site are favorable, these sorting sidings are laid to a fall of 1 in 80, or 1 in 100. This falling gradient allows the sorting to be per-

AN ENGLISH ROADSIDE GOODS STATION.

SIDINGS AND GOODS SHED AT A SMALL ENGLISH STATION.

formed by gravitation. Otherwise shunting locomotives, and sometimes horses, are used.

In recent years the growth of traffic, and the acceleration of the speed of goods trains as well as passenger trains, have compelled the railway companies to expend vast sums in widening their trunk railways and in laying down many hundreds of miles of additional running lines alongside the original double road.

Thus the London & North Western Railway had, at the date of the last-published returns, 29 miles of three-line road, and 177 miles of four or more lines, against 1,306 miles of double line.

This widening of the road is always more troublesome, and often more costly, than the construction of a new railway, but it is especially difficult in passing through the stations. There the provision of additional running lines very often involves the entire re arrangement of the yards, and thus very frequently buildings are pulled down for this reason as well as for extensions and improvements (some have already been rebuilt twice). Yet, with few exceptions, the buildings erected for railway traffic—of all kinds—are solidly built. Brick walls and slate roofs are the rule, timber and galvanized corrugated iron being seldom used either for walls or for roofs.

For the diagram plans and for permission to photograph the Somers Town depôt, and also for many of the particulars herein, the writer is indebted to Mr George H. Turner, the general manager of the Midland Railway; thanks are also due to Mr Alexander Ross, the chief engineer of the Great Northern Railway, for permission to photograph the Farringdon street depôt.

REVIEW OF THE ENGINEERING PRESS

CONTENTS.

RCHITECTURE AND BUILDING.

The Strength of Bins.......... 304
The Preservation of Iron in Buildings....311
The Action of Fire on Structural Steel....312
Foundations in Compressed Earth.......318
The Exposition of 1900.......... 323

IVIL ENGINEERING.

Excavating Devices. 304
The Melan Arch in America 307
A Proposed Russian Ship Canal.........317
The Bouzey Dam Disaster...............319
A New Bridge at Berne................ 322
The Simplon Tunnel... .... .323

CONOMICS AND INDUSTRY.

The Struggle in the Engineering Industry 314

LECTRICAL ENGINEERING.

The Bakersfield Transmission...........303
The Precision of Electrical Engineering..306
Bleaching by Electricity... 324
The Physiological Action of X-Rays. ...324

ARINE ENGINEERING.

The Building of the Oceanic.............312

MECHANICAL ENGINEERING.

Confidence in Safety Appliances..........301
Powdered Fuel............ 303
The Extension of Niagara Power Plant...305
The Great Falls Power Plant....... 306
Armor Piercing Projectiles...............311
A Pumping-Engine Test 313
The Entropy Diagram............... . 319
Military Bicycles.......................320
The Development of Hydraulic Power...321

MINING AND METALLURGY.

The British Coal Industry........... ..315

MUNICIPAL ENGINEERING.

Asphalt Pavements............... 308
Refuse Destructors.....................309
The Sanitary Congress at Leeds.........309

RAILROAD AFFAIRS.

Electric Traction on Elevated Roads 302
Oil-Fired Locomotives 311

STREET AND ELECTRIC RAILWAYS.

The Dover Tramway....................316
Traveling Platform at Paris Exposition...317

Confidence in Safety Appliances.

THE recent accident to an elevator in ne of the modern office-buildings in New 'ork city, by which two lives were lost as caused some comment as to the genral question of the reliability of the safety evices which are expected to make such asualties impossible.

We are in the habit nowadays of trustng ourselves in very many ways to the are of mechanical appliances. Not only elevators, but on railways, in electric ghting, in building construction, and in any other lines, our lives are constantly ependent upon the prompt and absolute eliability of the automatic mechanical deices which have been thought out with reat care and constructed with the best nechanical skill available.

The public confidence in the safeguards laced around the innumerable sources of anger is fully justified. In spite of the normous increase in the number of posible mechanical dangers, the death-rate iminishes continually. When a safety appliance acts, little or no notice is taken by the public, if, indeed, the fact that it has acted is known at all, but every failure is given wide publicity.

In the case of the fall of the elevator in the Tract Society Building, of which an account is given in the *Scientific American* (September 25) and in *Engineering News* (September 23) it appears that the safety device intended to hold the car in the event of falling did act at one of the lower floors, and was then released by the engineer, who, however, left the releasing-bar in place, instead of removing it, thus preventing its action a second time That second demand upon the safety check came a few minutes later, and both engineer and elevator-boy fell from the top to the bottom of the shaft, in the car, the ropes all apparently having been ruptured by overwinding.

Such an occurrence is really no condemnation of the safety clutch, since the presence of the obstructing bar practically deprived it of existence as a safety device, and, under such circumstances, should cause no apprehension to passengers on other elevators. It should, however, cause still further study to be given to the subject of safety appliances from a different standpoint.

A safety check must not only work perfectly when let alone, but it should also be practically impossible for any one to tamper with it, or prevent it from working, either carelessly or intentionally. How this result can best be achieved is a matter for the elevator-designers to decide. Possibly something in the line of interlocking devices, by means of which motion of the hoisting mechanism would be prevented until the safety check was freed, may be the solution of the problem. Or a duplication or multiplication of independent checks, just as a multiplication of time-lock movements is used to prevent lockout on bank vaults, might guard against any failure of a single device. Whatever means be employed to render accidents still less probable can only increase a confidence which is even now not misplaced, for the conditions under which the recent disaster occurred are most unlikely to be repeated.

Electric Traction on Elevated Roads.

THERE has been much discussion at various times as to the feasibility of substituting electricity for steam on elevated roads for municipal service, while at the same time the data from which definite information must be deduced have been lamentably scarce. We now have a most valuable contribution to our stock of working information on the subject in the shape of a paper read before the American Institute of Electrical Engineers at its recent convention by Mr. M. H. Gerry, Jr., and published in the *Railroad Gazette* (Sept. 24). Mr. Gerry's paper deals with the facts brought out in the operation of the Metropolitan Elevated in Chicago during the past year, and is thus based upon an exceptionally heavy and important traffic under very trying conditions.

In a service of this sort the frequency of the stops and the inequality of speed render the performance scarcely comparable with ordinary railroad duty. There is no opportunity for maintaining the speed, as the distance between stations averages only about two thousand feet, and the running time depends almost entirely upon the rate of accelerating and retarding the train. The traffic is also very irregular, being heavy at certain hours, and apt to increase and decrease at a rapid rate.

This irregularity is well shown by the diagrams of load-curves for the different days of the week, while a very interesting series of speed- and current-consumption-curves shows the effect of the frequent stops. The load-curves form a very sensitive index of the traffic, unusual increase of travel from any cause being noticed at once in the power-house. It is interesting to note that this is due not so much to the increased weight of passengers as to the longer stops, which demand a higher speed to keep the trains on time. The actual weight of paying load carried bears so small a proportion to the dead load that any moderate variation is in itself scarcely appreciable.

The following averages from a tabulated statement of a number of tests made on trains of the Metropolitan Elevated Road serve to indicate the efficiency of electric traction under such conditions. For trains of three cars on runs of 28 minutes, of which less than 2 minutes was consumed by stops, an average speed of 13.8 miles per hour was attained, including stops; or 14.1 miles, not including stops. The average current, including stops, was 122 amperes, or, not including stops, 129 amperes, and the average voltage at train was 512 volts. The efficiency from the generators to the car-axles was 50.8 per cent.; the kilowatt-hours per car-mile at train was 1.47, and at the station 1.57.

Electrical energy can be produced at Chicago with cheap coal at less than half a cent per kilowatt-hour; or, with an efficiency of 50 per cent., the mechanical energy at the car-axles is about one cent per kilowatt-hour, from which comparisons with steam locomotives can readily be made. Mr. Gerry wisely adds that mere economy in motive power is not the only feature to be considered and that the greater flexibility and simplicity of electric over steam traction add to the commercial advantages. He favors the third-rail system whenever available, believing that for roads operating their own right of way there is no serious objection to its use, while the experience already gained justifies the statement that a reliable overhead or conduit system for heavy service can be constructed, if the conditions favor the use of such methods.

Powdered Fuel.

RECENT trials in New York of the Wegener system of burning powdered coal under steam boilers are discussed in *Engineering News* (September 16), together with some account of the successful tests of the method in Germany, France, Switzerland, and elsewhere. The principle of the Wegener apparatus is not apparently different from that of various former attempts to burn coal in powdered form, and the use of finely-pulverized coal intimately mingled with air and delivered into the furnace with or without forced draft has been attempted many times since the experiments of Crampton nearly thirty years ago.

There is no doubt that coal can be thoroughly and economically burned in this way, and that, when the fuel is reduced to a fine powder and thoroughly mixed with the air, little or no smoke is produced in the combustion. The chief impediment to the practical application of the system lies in the inconvenience and expense of grinding the coal. It is admitted that the cost of grinding the fuel to such a fineness as will enable it to pass a sieve of 125 meshes to the inch will be 10 per cent. of the cost of the coal, which in itself is worth considering.

So far as comparative economy is concerned, powdered fuel shows about as good results as are obtained with other first-class mechanical stokers, giving evaporations of 9 to 11 pounds of water per pound of coal (no allowance for ash) and 70 to 75 per cent. in boiler-efficiency; but, as these results are charged with the cost of powdering the coal, it is questionable whether there is any real advantage. The comparative tests made in Europe were with furnaces which showed only 55 to 60 per cent. in boiler-efficiency with hand-firing, and hence can hardly be considered applicable for determining the relative value of the Wegener system as compared with automatic stokers; and even hand firing, with skilled firemen and careful regulation, will give results which approximate 70 per cent. in efficiency.

When, as is suggested by *Engineering News*, the Wegener furnace is compared with other improved methods of burning bituminous coals,—down-draft, under-feed, etc.,—in fire-brick furnaces, one cannot doubt that results fully equal to those obtained by the use of powdered coal may be secured without spending, for grinding, 10 per cent. of the cost of the coal, besides paying costs of installation, royalty, and maintenance.

The Bakersfield Transmission.

AN interesting feature of the hydraulic and electric power plant at Bakersfield, Cal., in which 2,500 h. p. of the Kern river is utilized, and which is fully illustrated and described in the *Journal of Electricity* (August, 1897), is that practically all of the power is to be used in pumping water for irrigation purposes. The Kern river itself does not supply sufficient water to irrigate the thousands of acres directly, but what it lacks in volume it makes up in energy. Kern county is underlaid with ground water about twenty to thirty feet below the surface, and, by converting the energy of the river into electricity, transmitting about twenty-five miles, and using it to operate centrifugal pumps, sufficient water may be pumped to the surface to irrigate the land effectively.

The plant thus offers an example of transformation of water not dissimilar to electrical transformation, in that a moderate volume at high pressure is transformed into a large volume at low pressure, and the intervention of the turbines, generators, and electrical transmission forms an intermediate detail of this unique installation.

Mechanical Excavating Devices.

AMONG the important and interesting papers presented before the recent meeting of the American Institute of Mining Engineers at Chicago, that of Mr. J. F. Lewis upon the Chicago Main Drainage Canal possesses especial value as illustrating the advances which have been made in machinery for excavating and handling earth, rock, and similar material. In fact, apart from a discussion of the geological features of the work, Mr. Lewis's paper is chiefly devoted to an account of apparatus either modified, or especially invented and constructed, for the purpose of replacing older and slower methods. In several instances contractors found it impossible to perform the work at the contract prices, except at serious loss, when using the ordinary steam-shovel and car plant, while new contractors, by installing modern conveyors, steel belt excavators, and other special appliances, were able to make money at even lower prices.

This was notably the case with the more difficult portions of the excavating. In one case the first contractors for one of the sections removed some 70,000 cubic yards of cemented boulder-clay at a cost of 69 cents per cubic yard, when their bid was only 27½ cents. They then gave up the undertaking, whereupon the contract was re-let to others, who, with improved incline and tipple plants, were able to do the work successfully for 27 cents per cubic yard.

In another instance contractors paid the builders of the Brown Cantilever apparatus 15 cents per cubic yard for conveying rock from the pit to the dump, when experience developed that the actual cost, including labor, fuel, oil, waste, and repairs, amounted to only 2 cents per cubic yard.

The apparatus used on various sections of the canal included inclines and tipples, bridge conveyors, cantilevers, steel belt conveyors, and traveling cableways, together with powerful steam excavators and revolving derricks, all of which are illustrated from photographs in Mr. Lewis's paper, together with maps, sections and diagrams relating to the work in general. The work is an excellent example of the development of special means to attain a special end, and the results accomplished by the improved devices used upon the Chicago Drainage Canal should cause a revision in the methods of estimating the cost of similar work.

The Strength of Bins.

THE recent failure of a large coal-bin, and the consequent stoppage for a time of the Paterson electric power station, has caused some discussion as to the actual behavior of granular materials when stored in bulk, as well as the proper method of computing the strains upon the bins.

The Paterson failure is very fully discussed in *Engineering News* (September 23), both from the builder's standpoint, and in an editorial dealing with theoretical principles, and, while the immediate cause of the accident does not yet clearly appear, some interesting points are brought out. The economy in handling which is obtained by dumping the coal in bulk into bins, from which it can be fed to the boilers direct, has led to the very general adoption of this arrangement in the numerous power houses and large steam plants of recent erection, and the location of these overhead bins is necessarily such that in most cases the consequences of failure would be most serious, possibly including loss of life.

The importance of providing a large margin of safety, both by correctness of design and excellence of material and workmanship, should be always considered under such circumstances, and, in view of the limited amount of information accessible, the present discussion is not without value.

It is the general practice to consider granular materials—coal, sand, grain, and the like—as exerting a lateral pressure depending upon the angle of repose assumed by the material when piled freely in an open space. Theoretically this seems reasonable, but it is not always wise to assume that the lateral pressure thus deduced is the greatest that can come upon the walls of the bin. The internal friction of a granular mass is not necessarily constant, and it is by no means impossible that the withdrawal of coal from below might set up a motion within the mass which would produce much greater stresses than those theoretically assumed; while temporary obstructions to flow, when suddenly overcome, would add the influence of impact. Our contemporary is decidedly on the safer side in recommending that the mass be considered, for purposes of computation, as acting like a liquid, and the center of pressure be assumed as at the point corresponding to liquid pressure, rather than at the point where a line through the center of gravity of a solid would fall.

Under such assumptions a bin should be computed just as if it were to be a tank for water, taking into account the specific gravity of the substance to be stored. When with these assumptions a designer shall take a sufficiently low fiber stress to provide ample margin of safety, such as the serious consequences of failure demand, he will have taken only reasonable precautions against disaster.

The Extension of the Niagara Power Plant.

So much has been written about the Niagara power plant that the subject seems almost threadbare, but the paper recently read before the Engineers' Club of Philadelphia by Mr. Chas. F. Scott, and published in the *Transactions* (July–Sept.), gives some very interesting information about the practical performance of the plant during the past two years of its operation, as well as the extension of capacity now being made.

The original installation involved both electrical and mechanical units so much larger than had previously been made that there was room for much difference of opinion as to the details of construction to be adopted, and, with every care and precaution possible, it was yet admitted that there were many elements of experiment in the apparatus.

Prior to the construction of the works at Niagara no turbine of 5,000 h. p. had ever been built by any manufacturer, and even in Switzerland Messrs. Faesch & Piccard, by whom the turbines were designed, had previously made nothing larger than a turbine of 700 h. p. With this problem was involved the transmission of 5,000 h. p. through 140 feet of vertical shafting, including the supporting and counterbalancing of the great weight in motion; while above all came the generator to convert this unprecedentedly large hydraulic unit into electrical energy.

Three such units were successfully installed, and have been in satisfactory operation for more than two years, and the most emphatic approval that can be given to the original plans is found in the fact that they are now practically to be repeated in the extension of the plant. To quote from Dr. Coleman Sellers's remarks upon Mr. Scott's paper: "At the present time the wheel pit and power-house at Niagara Falls are being extended, and new machinery is well under way. Five units, each of 5,000 h. p., will be added to the three now in operation. The extension of the machinery is in harmony with the present plant, which was considered experimental by most engineers. A careful study of the operation of the turbines and of the dynamos has enabled improvements to be made in the direction of simplicity and increased durability. The efficiency promised by the makers of the existing plant was deemed by many engineers as problematical. For the new machinery a higher efficiency is guaranteed, and I have confidence in the result. The new dynamos will not differ in outward appearance from those in use, the changes being mainly in the armature for the diminution of copper and iron losses, and more perfect ventilation."

With these slight modifications, then, the work of the designers of the original plant is to be repeated in the extension, to the undoubted credit of all concerned. In this respect Dr. Sellers himself is especially to be congratulated, since the work has been under his skilful direction from the start.

In addition to its very clear and interesting description of the existing plant, Mr. Scott's paper brings out the fact that a large portion of the energy utilized at Niagara is employed in industrial operations which are the direct outcome of the new source of power. The electrolytic reduction of aluminum, and of metallic sodium, the production of carbids of silicon (carborundum) and of calcium, with other electro-chemical industries, use much of the chemical and thermal energy of the current, and these are dependent for their commercial existence upon the presence of abundant power at moderate price. As Mr. Scott concludes: "The important enterprises at Niagara are new. The processes are among those which electricity has so recently given to the arts. They are large consumers of power, and their commercial practicability depends upon its cheapness. In ordinary manufacturing industries the cost of power is a small percentage of the cost of material and labor, and the power is used only a small part of the day. In the industries at Niagara, the cost of power is the vital element, and, while, on the one hand, their continuous operation makes them ideal customers of a water-power plant, on the other hand, they are significant omens of the advance in the industrial methods which is made possible by abundant and cheap power."

The Great Falls Power Plant.

HYDRAULIC power has exhibited an unprecedented development in the past few years, in connection both with long-distance transmission and with immediate use in local industries. Among the latest plants completed in the United States, that at Great Falls, Montana, is of especial interest, not only because of its magnitude and constructive importance, but also because the current is principally to be used in the electrolytic reduction of copper. Between 40 and 50 feet head of water is available at Great Falls, and this is utilized to develop 2,800 h. p. by what is claimed to be the largest and most powerful pair of horizontal turbines ever built for such a head.

From an account of the plant given in the *Scientific American* (September 25) the following points of interest are given. The two turbines, each 57 inches in diameter, are placed horizontally at the ends of a cast-iron draught chest, and discharge centrally through a plate-iron draught tube 10 feet in diameter. The turbines and draught chest are inclosed within a huge cylindrical flume 14 feet 4 inches in diameter and 32 feet 6 inches long, built of ½-inch steel, the ends being closed by cast-iron covers with stuffing-boxes for the shaft, the turbines and draught chest being thus entirely inclosed. The water entering the flume passes through both wheels in opposite directions, thus neutralizing all axial pressure, and flows down and out through the draught tube. The wheels are carried on a 10-inch shaft, to which at each end is coupled a 1,000-h. p. Westinghouse electric generator, while power is also taken off by belting for two 50-h. p. exciters as well as an arc-lighting dynamo. Test of these wheels at Holyoke showed the excellent efficiency of 81¼ per cent., at three quarters to whole gate, and the whole installation, while containing nothing radically new, reflects much credit upon the builders, the Dayton Globe Iron Works, for the magnitude and successful performance of the plant.

The Precision of Electrical Engineering.

UNDER the above title Dr. Francis B. Crocker presents his inaugural address as president of the American Institute of Electrical Engineers, published in *Electricity* (September 8), and takes occasion to refute the too-widely-spread idea "that electricity is so imperfectly understood that its laws and actions are little more than matters of chance or guesswork."

The claim is made that electrical engineering, far from being an inexact or crude science, is more precise than many older branches of engineering. In maintenance oft hese claims, Dr. Crocker cites a number of points. After calling attention to the list of great names of distinguished men noted for their devotion to the exact sciences and inseparably connected with the development of electrical science, he points to the rapid progress and great results accomplished, as proofs of the precise nature of the knowledge possessed of the laws governing the application of electricity. So certain or rapid progress could not have been made by blindly groping with cut-and-try methods; uncertainty would necessarily have caused delay, and error would have involved repeated trials. "The fact that the difficult arts of long-distance transmission of power, and electric traction, have been developed to their present state of importance and success in about ten years shows conclusively that electrical theories and designs agree very closely with the actual facts."

Again, the close relationship between pure and applied electrical science is given as proof of the exactness and truth of both, and numerous examples may be given showing the agreement between computed values and experimental determinations. Instances of this agreement between electrical theory and fact are found in the development of the theory of electro-magnetism by Ampere within a few days after its discovery by Oersted, and in the close corroboration of Maxwell's theories by subsequent investigations. Another point distinctly bearing upon the claim for precision in electrical science is the exactness in electrical units and terms. In this respect electrical science certainly possesses a great advantage over older branches, the system being not only definite and precise, but also international, and accepted all over the world.

The accuracy of electrical measurements, and the facility with which they are made, also contribute greatly to the precision of electrical engineering, the methods of exact science being thus brought into the daily practice of the electrician to a greater extent than in almost any other branch of applied science.

As a single example of the precise results attained in electrical work, Dr. Crocker cites the location of faults in ocean cables. In the case of a cable thirty miles long coiled in a tank a fault in the gutta-percha has been determined to within a probable error representing about twenty feet of length. In ocean cables the average error in practice is about a mile and a half, and under favorable circumstances much less.

In designing generators, the efficiency can be predetermined from the drawings, before the machine is built, within a fraction of 1 per cent. and it is sometimes questioned whether the probable error in testing the completed dynamo is not greater than that of the preliminary computation. A tacit admission of the greater accuracy with which electrical measurements can be made, as compared with those of other forms of energy, is found in the fact that, when it is desired to test the amount of power required in any given case, the quickest, neatest, and most mechanical method is the use of an electric motor. In this way tests of the lubricating values of oils have been made, as well as the power consumed by fans, pumps, or other machines.

The Melan Arch in America.

A NOTE in *Engineering News* (Sept. 23) upon the progress of the Melan Arch bridge now under construction at Topeka, Kan., is of interest as calling attention to the value of this combination of steel and concrete.

In Europe the use of metal and concrete has become frequent. The Monier system was originally devised to introduce metal merely to sustain tension, and thus enable an arch to resist forces which otherwise would cause rupture of masonry. Prof. Melan went further than this, and practically substituted light steel girders for the skeleton of the arch, these being imbedded entirely in a mass of concrete.

The principle has been carried still further in one of the designs for the proposed bridge at Berne in Switzerland, in which an arch of two hundred and forty feet span is designed with an internal structure of steel lattice-work, the whole being encased in concrete, so as to resemble, when completed, an arch entirely composed of masonry.

The excellent results obtained with the Monier arch of seventy-five feet span, tested at Vienna, should encourage American engineers to a more general use of these methods of combined metal and concrete construction, the advantages being on the side of both economy and security.

Asphalt Pavements.

ASPHALT, as a material for street-paving, is coming more and more into use, but the opportunities for obtaining reliable information upon the subject have been very limited ; hence the paper of Mr. George W. Tillson, presented before the American Society of Civil Engineers, and printed in *Engineering News* (September 2), is a welcome addition to the literature of municipal engineering.

The industry, which was still in its infancy in 1880, has assumed vast proportions, there being in the United States alone, as nearly as could be ascertained on January 1, 1897, nearly 27,500,000 square yards of asphalt pavement, to which the present year will make large additions.

Mr. Tillson gives an interesting account of the methods employed in procuring the crude asphalt from the various localities in which it occurs, and also describes the so-called refining processes, which practically consist in heating the crude material long enough to drive off all the contained moisture and remove the volatile oils. The solid matter settles to the bottom, and the refined material, constituting about 60 to 70 per cent. of the crude asphalt, is drawn off for use.

In the present state of our knowledge but little can be learned about the value of a sample of asphalt by chemical analysis. To quote from Mr. Tillson's paper :

" Whether an asphalt will or will not make a good pavement can only be told by trying. A chemist can analyze an asphalt, tell what are its component parts, and give his idea as to what it ought to do, but the author doubts if any one would be willing to give a definite opinion as to its action in a pavement simply from a laboratory analysis. Personally the author would hesitate before giving a final judgment on a pavement that had not passed through at least two winters. An analysis of the refined asphalt is required to ascertain the quantity and quality of the bitumen contained. Then, by former experience with other asphalts, and many experiments, the quantity of flux is determined, taking into consideration the climate and the amount of traffic."

Strictly speaking, the asphalt does not form the pavement proper, but is only a surfacing, and, as Mr. Tillson well remarks, " the foundation is the important part of an asphalt pavement. The surface coat is only the carpet; the base must be the floor that sustains the load. No matter how good the top may be, a failure in the base means the immediate failure in the pavement."

The best foundation is made of hydraulic cement concrete of thickness varying with the traffic, but never less than six inches. Between this and the surfacing is placed the so-called " binder " of clean broken stone, cemented together with asphaltic cement, no more cement being used than is absolutely necessary to bind the stone together. This binder counteracts the tendency of the surfacing to creep on the foundation, and unites the whole firmly together, and, when the work is well done, grades of seven to eight per cent. can be successfully used.

It is a general impression that asphalt is slippery, and this has been urged as an objection to it as a paving material. The source of slipperiness is the presence of dirt upon the smooth asphalt surface; when the pavement is kept thoroughly clean, either by washing or otherwise, little trouble is experienced.

A Correction.

BY an unfortunate confusion, the illustration of the Cunard Royal Mail Steamship Russia, appearing in the September issue of THE ENGINEERING MAGAZINE (Vol. XIII, page 910), was underlined with the statement that the vessel was lost off the coast of New Jersey.

Probably the extraordinarily successful and widely-known record of the Cunard Steamship Company furnishes a sufficient correction to most of our readers; but it is due to all to state that the Russia, after many years of excellent service in the Cunard line, was sold to other owners, and, so far as obtainable information goes, may still be in use.

THE BRITISH PRESS

Refuse Destructors.

AMONG the various methods of disposing of household refuse and garbage the use of destructors or incinerators has often been suggested; and of late, notably in the much-discussed plant at Shoreditch, the heat produced by the operation has been utilized for the generation of steam.

A refuse destructor, in order to be entirely satisfactory, must, above all things, be absolutely effective and inoffensive, and one of the greatest difficulties encountered in the installation of incinerating plants is the supposedly offensive nature of the operation, causing strong opposition from every one in the vicinity of the proposed location. In order to insure a thorough combustion, and entire conversion of all organic matter, it is advisable to use an independent heating furnace, fed with coal or coke, both to furnish the initial high temperature needed to start the combustion of the refuse, and also to maintain a higher degree of heat than could be attained by the burning of the refuse alone. The higher original cost of incineration by this method is more than compensated for by the completeness of the combustion, and a large portion of the value is recovered in the steam-generating plant, when such is used.

A refuse destructor on this principle has been constructed at Lewisham, and is illustrated and described in the *Engineer* (September 17). It is said to work very satisfactorily. The incineration is effected in an inclined revolving cylinder twenty-six feet long and seven feet in diameter, made of iron and lined with fire-brick. The furnace delivers its gases into the higher end of this cylinder, and heats the fire-brick red-hot, after which the refuse is gradually fed in while the cylinder is revolved. The intense heat of the fire-brick at once starts the incineration, while all fumes from putrescent organic matter are fully consumed during the passage through the cylinder. The angle of inclination is such that the rotation causes all solid matter to move forward, and ultimately to be deposited in a char pit, while the gaseous products of combustion pass on through a horizontal flue to a water-tube boiler, and thence to a chimney, 121 feet high.

The Willoughby destructor, as installed at Lewisham, is not yet complete, in that no steam-generating plant has been placed in the flue; for the present a water-spray is used to cool the discharged gases, which otherwise would reach the chimney at a temperature of about 2,000° F.

In its present arrangement the Lewisham destructor incinerates 72 tons in 24 hours, about 30 per cent. consisting of solid residual, such as dust, breeze, chards, tin, glass, etc. The dust and breeze is sold, and the total net cost, including fuel and labor, amounts to about one shilling per ton, of which one-third is for fuel.

As the heat is not yet utilized, the return from steam generated is not included in the above cost, and it is impossible to state just what economy will be effected by the addition of a steam plant, but there is little doubt that a combination of destructor and electric or power plant could be made a paying investment.

The Sanitary Congress at Leeds.

THE Sanitary Institute in recent session at Leeds dealt with some important subjects pertaining to health and comfort, and of reports in the *Builder* (September 18) and the *Architect and Contract Reporter* (September 17) we make abstracts.

In his presidential address, Dr. Farquharson dealt with the importance of man's physical condition as a requisite to the progress of the race, and the part which sanitation necessarily plays in human progress. The diminution of the death-rate, however, should not be taken as a proportional index to the rate of sanitary advance, since the reduction in the rate must necessarily proceed more and more slowly, gradually approaching a probable minimum of 14 to 15 in the thousand, the mutual elements of decay inherent in mankind hardly permitting a lower figure to be reached.

Among the points bearing more directly upon the technical side of sanitation the value of light may be mentioned. When natural light cannot be obtained, even its imitations are useful, and Sir W. Preece found that in a department of the London post office the introduction of electric light diminished the sick absence by two days per annum.

The strong points made by Dr. Farquharson were, firstly, "drastic radical legislation by which the local bodies may be able to acquire land compulsorily, on paying full compensation, for building workmen's houses; and then quick and cheap railway traveling, rendering it possible for city workmen to live in the surrounding country."

The seemingly endless discussion upon the subject of smoke-abatement received its due share of attention at the congress, and some good points were brought out. Much of the excessive smoke-production is due to the forcing of inadequate boilers. "A great many manufacturers try to make a set of boilers do far more work than they are able to, to the detriment of the atmosphere." In Leeds, however, and probably in most cities where soft coal is generally burned, the manufacturers are by no means the greatest offenders. Statistics were furnished to prove that on Sundays, when the factory chimneys are quiescent, the impurities in the air are only twenty-five per cent. less than on week-days, thus showing to what an extent domestic fires were responsible for the smoke nuisance.

In discussing the question of ventilation, its close relation to warming was made apparent; indeed, it is impossible, in cold climates at least, to consider the one without taking the other into account. Many buildings also, especially those in which many work-people are engaged, cannot be properly ventilated under existing conditions without producing continuous draughts.

Oil-Fired Locomotives.

Notwithstanding the fact that a careful investigation of the subject of oil-firing for locomotives by some of the leading railroad companies of the United States has resulted in negative recommendations, the use of oil fuel has continued to find favor on the roads tributary to the Russian oil fields, and is also extending in England.

The Cromer express, on the Great Eastern Railway, is claimed to make the longest and fastest continuous run made by any oil-fired engine now running, and an account of the trip, given by a correspondent in the London *Engineer* (September 17), contains data about the practical side of oil-firing which are worthy of record.

The engine is a simple, single-driver locomotive of 42 tons weight, with cylinders 18 by 24 inches, and 7-foot drivers. The boiler has 1,217 square feet of heating surface, and 18 square feet of grate, and carries a steam pressure of 160 pounds.

The length of run, from Liverpool street to Cromer, is 130 miles, which is made in 160 minutes with one stop about eight miles from Cromer, making the excellent average speed of 48.75 miles per hour, with a train weight of not less than 180 tons, and frequently more.

The firing is done on the Holden system, the oil being sprayed over a bed of coal and broken fire brick upon the grate, the coal being necessary only to furnish an incandescent bed to receive the oil at starting. During the run the coal is gradually consumed, but the fire-brick, which is uniformly distributed over the grate, becomes incandescent, and not only serves to maintain the combustion of the liquid fuel, but also acts as a medium of radiant heat to the firebox surfaces of the boiler.

Notwithstanding the fact that grades as stiff as 1 in 100 occur on a portion of the line, the schedule time is well maintained, the speed reaching a maximum of 54.4 miles an hour for a stretch of 31¾ miles, and being limited through certain sections to from 30 to 35 miles.

The actual quantity of oil consumed is approximately 180 gallons, varying somewhat with the load and the weather, and the ease of firing and prompt control of pressure obtained with the liquid fuel are greater than would be possible with coal-firing. For an ordinary coal-fired engine to accomplish this service, it is estimated that about 2¼ tons of coal would have to be shoveled into the firebox for each trip. As the train has been running regularly with oil-firing during the past summer, the data thus obtained are much more useful for practical purposes than figures obtained by special tests covering but a limited period.

Armor-Piercing Projectiles.

THE success which has attended the new Hadfield projectiles in piercing Harveyized armor plate is the cause of some congratulation in British military circles, and not without reason, since until very recently the main dependence for armor-piercing projectiles was placed upon the Holtzer manufacturers.

In commenting upon this anomalous state of affairs, *The Engineer*, in the issue of September 10, speaks very plainly of English neglect to encourage the manufacture of armor-piercing shot, Hadfield being obliged to push on with his numerous experiments under much discouragement.

His labors appear now, however, to have attained material success, as the following account of the recent trials shows: "Two 6-inch Hadfield projectiles, of special design and quality, and with caps on their points, were fired with a velocity of 1,960 feet and 1,940 feet per second at a large Harveyed steel plate, 8 feet square and 6 inches in thickness. The plate on its upper surface had before received two 6-inch forged steel shots, neither of which had penetrated more than about 2½ inches. There remained about 70 per cent. of the plate area untouched and uninjured. In both cases the projectiles pierced the 6-inch plate and 2 feet of wood backing, and were found 15 feet to 20 feet at the rear, in the sand butt. Though broken, the wreckage and destruction of timber, bolts, and fastenings, caused by the projectiles, were especially great, showing the considerable remaining energy they possessed after passing through the plate itself. If this had been on a ship's side, the damage done would have been very serious, the broken portions, not one of which was found on the front side, acting as *mitraille*, as was proved by the shattered condition of the surroundings and the backing."

The good quality of the plate is demonstrated both by the fact that the previously-fired forged-steel shots penetrated only 2½ inches, and by the shattered condition of the Hadfield projectiles after the piercing. In view of the details given, it must be admitted that Mr. Hadfield has proved his ability to make a projectile decidedly superior to any yet tried against modern armor.

It is to be hoped that some of these new projectiles may be used in armor-plate trials in the United States also, in order that the severest test may be applied under well-ascertained conditions.

The Preservation of Iron in Buildings.

IN the issue of the *Builder* for September 11 is an article by Mr. H. C. Standage, discussing the effect of various paints and other preservatives of iron work used in building. Mr. Standage emphasizes the injurious effect of many so-called preservatives, which are themselves the first to start the conversion of the iron into oxid by the liberation of glycerine from the linseed oil used as a vehicle for the pigment. When the oil enters into chemical combination with the pigment, the glycerine is set free, and promptly absorbs moisture from the atmosphere, setting up erosion and beginning the destructive work of converting the metallic iron into rust.

The true theory on which the composition of preservative paints should be based then, according to Mr. Standage, is that of the absorption of the glycerine by some of the constituents. It is on this theory that he finds the reason for the admitted superiority, as preservatives, of paints containing either red oxid of iron (Venetian or Indian red) or red oxid of lead. Red oxid of iron combines to a great extent, and red oxid of lead completely, with the glycerine eliminated from the linseed oil, thus rendering it nearly or entirely harmless. In the case of red oxid of iron the action of the glycerine upon the metal does go on slowly, beneath the hard and dry exterior coating of the paint, and hence this cannot be considered a perfect preservative. Mr. Standage maintains that the only pigment which absorbs all the glycerine—the cause of all the mischief—is red lead. He also gives directions as to the preparation of a mixture for the purpose of toughening the red-lead coating, and adding to the strength of the film; but the fundamental principle is that above described. The presence of glycerine in paint has not been generally considered.

The Action of Fire on Structural Steel.

IN the course of a series of papers on "Fire-Prevention in Europe," Mr. Edwin O. Sachs gives in *Engineering* (September 24) some striking examples of the superior resisting power to fire possessed by timber construction as compared with structural steel or with cast iron. These examples are taken from the collections of photographs kept by the fire departments of Hamburg and of Bremen, and show very clearly the manner in which steel and iron yield and buckle when exposed to conflagrations which at the same time only char the surface of wooden posts and beams without causing failure.

The necessity of protecting structural steel work from the direct action of fire is well understood at the present time, and in buildings of recent erection, with reasonable claims to fire-resisting qualities, no unprotected beams or columns are permitted; but Germany is not the only country in which warehouses filled with combustible merchandise have been constructed within recent years, and are still in use, containing unprotected latticed columns, exposed beams, and corrugated iron surfaces.

The photographs published by Mr. Sachs, showing an utter lack of resisting power in buildings in extensive use, are far more instructive than whole treatises on fire-proof construction; and it is to be wished that collections of similar photographs were more generally available for reference by architects and builders.

Referring to the practice in Germany, Mr. Sachs says: "Photographs of this department are prepared of any important detail of construction which has had to withstand fire; also small folios with these photographs, to which are added particulars of the conflagration, information as to the construction, and frequently plans of the buildings involved. The movement for improved fire-prevention owes much to small labors of this kind, and, if more was done in this way, our architects and engineers would be better able to see the effects of fire on materials and on methods of construction generally than has been the case at present with improved tests or experiments."

There are doubtless many important photographs and records of the failure or success of various forms of construction to resist fire, but these are not always available for professional reference when most needed; nor is the accompanying information to be had. The American Society of Mechanical Engineers has at the present time an earnest and efficient committee at work, investigating the action of fire upon different forms of construction, and some valuable partial reports have been made; but, apart from this experimental work, a methodical record of actual performance would constitute an invaluable guide for future practice.

The Building of the Oceanic.

NOW that the *Kaiser Wilhelm der Grosse* has become an accomplished fact, attention is directed toward the next and still greater ocean-liner, the Oceanic, of which details are given in the *Engineer* (September 17).

The keel of the Oceanic was laid at the Belfast yards of Messrs. Harland & Wolff in February last, and the launch is expected next January, a remarkably short time for so enormous a hull; for it must be remembered that the length, 704 feet, is 25 feet greater than that of the Great Eastern, and 65 feet greater than that of any other ship, either afloat or in course of construction. The great size of the ceanic, as well as the short time in which ɛr completion is being attempted, have volved the adoption of various unusual :pedients, some of which are of sufficient terest to warrant description here; therere, from the columns of the *Engineer*, e give the leading features of the meth- ls adopted by the builders.

In order to provide room for the unusual ngth of the vessel, it was found neces- ıry to extend the building berth far be- ɔnd and below high-water mark, by ɪrming an immense coffer dam of heavy ıeet piling around the extreme end of ıe berth and inwards along the sides to ɔme considerable distance beyond high- ater mark. By closing this coffer dam at ʷw water, and keeping it clear of leakage ʸ pumping, work has proceeded on the t end of the ship continuously, regard- ss of the tide. While this adaptation of coffer dam is not new, it is here used on very large scale.

The rapid handling of materials in the ɔnstruction of the Oceanic is being ac- ɔmplished by a special arrangement of verhead traveling crane. For the support f the crane low walls of concrete have een built, clear of the ship's side and ex- ɛnding the entire length of the hull, and pon these walls tracks are placed, carry- ıg a gantry which spans the whole width f the ship well above the height of the ppermost deck. The gantry is provided ith hydraulic gear for longitudinal and ansverse travel, as well as for hoisting, ıd will thus cover the entire area occu- ied by the vessel in the same manner as modern power traveling crane covers ıe floor of a machine-shop or foundry.

This crane will be used, not only for ıe handling of materials of construction, ut for the support and control of numer- us portable power tools for drilling, rivet- ıg, and similar work. By the use of these nd other mechanical appliances the work pon the great ship will be carried on at much more rapid rate than would be therwise possible, and the extensive use f power tools should also add to the igh quality of the workmanship.

While the Oceanic is intended as a rec- rd-breaker in point of size, and also in coal endurance, no claims are being made for extraordinary speed. She is not intended to steam at twenty-seven knots, as has been reported, but is expected to have a sea speed of twenty-one knots,—one knot in excess of the Teutonic and Majestic, while for stanchness, safety, and luxury she is expected to surpass all predecessors.

The question of coal endurance has been considered, in view of the possibilities of the vessel as an armed cruiser, or as a transport ship for troops, and at a rate of twelve knots she will be able to steam 23,400 nautical miles, or practically the entire circumference of the globe, without coaling.

A Pumping-Engine Test.

THE *Engineer* of September 24 contains in full the report of a test of a pair of Worthington triple-expansion pumping engines, made by Simpson & Co., for the West Middlesex Water Works, and tested recently by Prof. W. C. Unwin.

The test makes a remarkably good showing for the engines, but our principal reason for referring to it here is rather to comment upon the admirable character of the test.

The engines are a pair of vertical, direct-acting beam pumping engines, with Worthington "high-duty" equalizing cylinders, the high- and intermediate-pressure cylinders being placed tandem over one end of the beam, and the low-pressure cylinder over the other, with direct connections to the pumps below. This arrangement was governed largely by the fact that the engines are placed in an old engine house designed for Cornish Bull engines, limiting the form and dimensions of the available space.

The dimensions of each engine are as follows: cylinders, 18½×29×45 inches bore; normal stroke, 60 inches. A speed of about 20 double strokes per minute was attained. Steam was supplied by two double-flued Lancashire boilers 7 feet 6 inches in diameter and 28 feet long, at a pressure of about 112 pounds absolute. For details of the test reference should be made to the original report. We may say, however, that the absolute thermal efficiency of the engines was a little more than 14 per cent., the duty per 100 pounds of coal about 116,000,000, and the coal-consumption 1.53 pounds per i. h. p., not allowing for about 5 per cent. of ash.

In order to investigate the full effect of all the forces, Prof. Unwin desired to take into account the action of the inertia of the moving parts of the machinery. This has frequently been done in most varieties of engines with crank and fly-wheel connection, in which the law of variation of piston-velocity can be assigned; but, until now, the effect of the inertia of the moving parts of a Worthington engine has not been investigated, the variation in velocity not being governed by determinate mechanism.

It was therefore necessary to construct a special apparatus for the determination of the velocity of the moving parts at various points of the stroke, and the purpose was ingeniously served by means of a pencil attachment connected to the piston-rod and describing a curve on a sheet of paper kept moving at a uniform rate. The vertical ordinate of the curve described represented the actual piston movement, while the horizontal abscissa was proportional to the time from the beginning of the stroke. From these data it was possible to construct an inertia curve, knowing the weight of the moving parts, and to combine this with the curve due to the action of the equalizing cylinders, and that of the expanding steam.

The entire resultant effect Prof. Unwin has plotted, reduced to the same horizontal base as that employed for the load on the pump-plunger plus the resistance due to engine-friction, and the final diagram shows very clearly how nearly the effort and the resistance are balanced in this particular engine.

Doubtless this method of including inertia effects in the diagrams of direct-acting pumping engines, thus first introduced by Prof. Unwin, will be adopted in subsequent tests to advantage and thus place the study of the action of the forces in direct-acting pumps on the same basis as in rotative engines.

The Struggle in the Engineering Industries.

THE exceedingly able paper by J. Stephen Jeans in our September number has placed the merits of this subject so well before the readers of this magazine, and has, doubtless, interested so many in the issues of the great contest in the English engineering trades, that an abstract of an appeal by the English employers to the general engineering industries of the United Kingdom, intended to stimulate resistance to the innovation of a 48-hour week, and to rouse those who, though they should become active in opposition, have hitherto remained indifferent or neutral, will be of further interest. This appeal is very strongly worded. If it fitly represents the feelings of English employers toward their employees, it indicates an intensity of antagonism even beyond what might be inferred from the statements of Mr. Jeans. The appeal (*Iron and Coal Trades Review*, July 30) characterizes the demand for a 48-hour week as ruinous, and states that organized labor has won its battles against the masters simply from the fact that the latter have not opposed to the demands of labor a similarly well-organized resistance. But now, the appeal proceeds, " for the first time in a very long period the masters in our trade throughout the United Kingdom have combined to resist. . . . To permit the men to defeat the masters in the present instance will lead to more vexatious conditions being imposed on our trade than has ever been the case before, bad as these have been. On sound commercial lines, guided by the facts which we, as principals, alone can possess, we know we are in the right. Argument with the labor leaders is useless; labor never descends to argument. . . . Labor only acknowledges one argument, and that is force. . . . Their success in the past is their only justification for their tactics. We must resist them with their own weapons, but ours must be more powerful than theirs, and wielded with greater determination. . . The trades unions never had such a powerful combination of employers to fight before, and cannot fight us ong, except with money raised from members who are still kept at work by employers who are not acting with us. Will you consent to pay wages to your men to help them fight us, your co-employers? or will you sink all trade jealousies and petty considerations by loyally joining us, ecognizing that our interests are identical, and that you are thereby protecting yourselves? The claim put forth by the advocates of the eight-hour day that the shortening of the day would result in an ncreased output per hour is held to be allacious, and a counter-claim is made, based upon data obtained from prime-cost books, that on certain classes of work he productive results of labor have been or some years less than formerly was the case." With reference to a certain shop wherein the eight-hour day has been adopted, and which professes satisfaction with the system, the appeal says that "they have therein established a system of supervision by extra foremen, and the enforcement of rules so strict that, were hey practised by any other firm, they would probably be designated by the union eaders as little better than slave-driving." And it is thought that, were the unions uccessful in enforcing their demands for a 48-hour week, they would not tolerate he general introduction of such a system. n conclusion, it is shown that the reduction of hours demanded and the abolition of overtime would necessitate the employment of thirty-one per cent. more men in order to obtain the same output.

The British Coal Industry.

THE condition of the British coal industry appears to be far from satisfactory, either to mine owners or to miners. Not only has the proportional output diminished, but prices have also fallen, until it has become a serious question as to whether an international agreement to control production and regulate prices may not become necessary.

A special article in the *Iron and Coal Trades Review* (September 10) discusses he troubles of the situation at length, and at the same time gives some interesting nformation about the changed position which England now bears toward an industry over which she formerly exercised undisputed control.

Up to about the middle of the present century Great Britain produced about two-thirds of all the coal output of the world. By 1866 this had fallen to 60 per cent.; in 1880, to 46 per cent.; in 1890, to 39 per cent.; and in 1895 to 36 per cent. At the present time the total coal output of the world is about 521,000,000 tons, of which the United Kingdom produces only about one-third. It is probable that fifty years hence Great Britain wlll not be producing more than a fifth or a sixth of the world's coal output, and that it will long before then have been left behind by the United States and Germany, if not by Russia, China, Canada, New South Wales, and other countries.

Various causes are cited to account for this unfavorable showing, but the one formidable fact which must be faced is the continual growth of foreign competition. The fact must be recognized that the British coal industry, great as it is, has passed its prime, and the present problem is to make the most of present opportunities, since England can never be expected to have a more prominent place in the world's coal industry than she has to-day.

The endeavor now is to find some barrier to stay the ebb of continually-falling prices, and this most naturally has resulted in plans to effect a combination that will to some extent control production, and thus steady prices, even if it cannot advance them. Such a combination, however, to be effective, must not be limited to Great Britain, although a combination controlling all the output of the United Kingdom would represent a capital of £200,000,000, and would be in itself a most important experiment in the aggregation of capital. But the combination would have to be international, and its possible magnitude has not been estimated.

According to a pamphlet recently produced by a continental writer, such a scheme would not aim to diminish the output, or produce an artificial rise in the price of coal, but would tend to "regulate the output," and "distribute the supply more regularly over every part of the year."

The writer in the *Iron and Coal Trades Review*, however, points out that any such agreement would be useless, unless the United States were included. "Already," says he, "American coal has invaded English markets. Open the sluice-gates by an artificial rise of price, and it would pour in like a flood. No; we may indeed be able to set our house in better order, but international agreement for the salvation of the British coal owner is out of the question, and some more excellent way must be tried."

Just what that "more excellent way" is does not very clearly appear, but at least a harmonizing of conflicting home interests is recommended, ultimately leading to district combinations, uniting into a general coal trust, with all that it involves.

The Dover Tramway.

ELECTRIC TRAMWAYS have until recently made less progress in England than on the Continent, and Europe generally is far behind the United States. England, however, is making up for lost time, and new roads are being projected and completed in many towns.

The *Railway World* (October, 1897) gives a fully illustrated account of the opening of the new electric tramway in the city of Dover, and the installation is of sufficient interest to warrant notice. The overhead-trolley system is used, the wires being supported on poles of decidedly tasteful design with ornate wrought iron brackets, and the effect is by no means unsightly. The mechanical and electrical features require no especial comment in these pages other than to state that Babcock & Wilcox boilers furnish steam to McIntosh & Seymour engines driving Thomson-Houston generators, so that the United States has furnished its due share of the plant.

Before the decision was made to introduce electricity as a motive power, comparative bids were had for operating the road on the Luhrig gas system. The first cost of the gas plant was about £8,000, against £12,780 for the electrical system, but the bid of the gas company for operating was 6½d. per car mile against 6d. per car mile for electricity, a difference which would much more than pay the interest on the larger capital required for the construction, the saving increasing rapidly with the increase of traffic. An attempt was made to introduce an act limiting the speed to 8 miles an hour, but after some contention this was only adopted provisionally, and higher speeds may be used subject to the assent of the Board of Trade. At the present time the road is only about 3½ miles long, and in order to secure travel the low fare of 1d. is charged, instead of 4d. previously charged by the omnibus company for the same distance.

The development of overhead trolleys in English towns will be watched with interest, especially as to the influence which may be exerted upon public opinion in the metropolis about overhead wires. The *Railway World*, in commenting upon this point, remarks: "We may add that the feeling regarding the overhead system, now that it has become familiar, is not unfavorable. As in Bristol, Coventry, and Leeds, there are no complaints, but a general wish that the tramways should be extended. It is the almost universal evidence that the anticipatory objections to the trolley system, as constructed in this country, have no foundation in fact. Why then, we are constrained to ask, should London wait? Cannot the County Council find courage enough to allow an experimental line, for instance, in the remote region of Hammersmith? Let them ask the Dover Council for advice: the reply would be interesting and useful."

THE CONTINENTAL PRESS

A Proposed Russian Ship Canal.

THE general interest developing in various parts of Europe in all matters relating to internal waterways seems to have extended to Russia, and a plan has now been made to construct a ship canal connecting the Baltic and Black seas by way of the rivers Duna, Beresina, and Dnieper. The terminal ports contemplated are Riga on the Baltic, and Kherson on the Black sea, and, as the greater portion of the distance is covered by the above-named rivers, the artificial waterway comes within reasonable limits of engineering construction.

According to an account in the issue of the *Zeitschr. d. Oesterr. Ing. u. Arch. Vereines* for August 13, the local conditions are especially favorable. The entire southern Russian plateau, in which the canal would be dug, is composed of a light layer of sandy soil upon a continuous bed of clay, admirably adapted for the construction of a water-tight channel, and—what is still more favorable—the variations in level are so slight that no locks whatever would be required.

The entire length of canal is estimated to be about 1,000 miles, and the proposed channel is to be more than 200 feet wide at the narrowest portion and 28 feet deep. The plans include docks at Riga and at Kherson, and the estimated cost, including all improvements, bridges, aqueducts, etc., is $100,000,000.

The great value of such a waterway lies not only in the communication which it would furnish between the two seas, and the local traffic through the richest portion of the empire, but also in the fact that it would place the northern nations of Europe in direct water communication with India and the east, through the Suez canal, by way of the Black sea and the Baltic.

It is proposed to finance the scheme by a government loan at 4½ per cent., the government to receive one-third of the net receipts during the concession period of sixty-six years, after which the canal will revert to the government without further payment. The earning capacity of the canal is estimated on a basis including travel both by day and by night, it being planned to equip the work with electric lights from the start.

Although the plans for this great work are as yet only in a preliminary stage, there seems to be nothing to prevent successful execution, so far as engineering problems are concerned; and money expended upon internal improvements should prove at least as good an investment as that allotted to military purposes.

The Traveling Platform at the Paris Exposition.

THE administration of the Paris Exposition of 1900 is already making plans for intramural transportation, this being especially necessary in view of the scattered nature of the area under consideration.

Many of the visitors at the World's Fair at Chicago will remember the traveling sidewalk with double speed which operated upon the pier, and it is a modification of this device which has been submitted for adoption at Paris on a much larger scale.

The traveling platform, as it is called, is described and illustrated very fully in the issue of the *Génie Civil* for July 3, the difference between the proposed construction and that at Chicago being mainly in details and magnitude. It is proposed to build the roadway upon an elevated structure similar to that of the elevated roads in New York, or the Intramural Road at Chicago, with convenient stations at intervals, two speeds being furnished, and the whole being propelled by electric motors.

The whole design, which is that of MM. Blot, Guyenet, and de Mocomble, shows evidence of a full appreciation of the difficulties of the problem when considered upon so large a scale, as the proposed system is intended to pass entirely around three sides of the Champ de Mars, along the Quai d'Orsay and the length of the Esplanade des Invalides, back to the Champ de Mars, forming a continuous circuit about three miles in length.

In the Chicago moving sidewalk the high-speed portion was provided with rails beneath, these rails resting on the tops of the rims of the wheels supporting the slower section, and thus a double speed was obtained without additional mechanism. This plan, however, is not thought desirable for so long a road as that at Paris, as the weight adds much to the momentum of the platform, and the absence of springs makes the motion rough and uncomfortable.

The proposed platform system consists of two entirely distinct portions, each with its own motive power, and each forming a continuous and endless platform traveling around the circuit of the grounds. The high-speed portion is intended to have a speed of about six miles an hour, and the slow section one-half as great a velocity, while a stationary sidewalk of ample width runs along the entire length of the circuit, enabling visitors to leave at any portion of the grounds and descend to the surface by the nearest stairway.

One of the valuable points of such a system is its great capacity, as practically the entire circuit is available for passengers, and no time is wasted in stopping and starting. Seats are to be provided on the high-speed portion of the platform, and it is estimated that fifty thousand passengers can readily be transported per hour. The length of the route, as planned at Paris, will demonstrate the practicability of the system for city streets, and the successful outcome of the construction at the Exposition may lead to decided modifications in existing overhead transportation systems in large cities. The absence of noise, smoke, and dirt, together with freedom from crowding, waiting for trains, and all the inconveniences of the present system, certainly furnish ample inducements for a further investigation of the success or failure of the installation.

Foundations in Compressed Earth.

At a recent meeting of the Society of Civil Engineers of France a simple method of constructing foundations in soft earth was discussed, and, as the subject is one of sufficient interest to be more widely known, we give a somewhat detailed account of the method, from the issues of the *Moniteur Industriel* for July 17 and 24.

The method is due to M. Louis Dulac, and consists in an ingenious mechanical compression of the soil. It is well known that, when a stake is driven into the ground, a compression of the surrounding soil takes place, equal in volume to that displaced by the stake. In the method of M. Dulac an apparatus like a pile-driver is erected, but, instead of the ordinary hammer-head ram, a heavy cone is allowed to drop, point down, in such a manner that it makes a hole, the size and depth of which depend upon the diameter of the cone and the height from which it has fallen.

The cone generally used is from 24 to 30 inches in diameter, weighing about 3,000 pounds, and it is dropped from a height of 30 to 40 feet. With a drop of this sort a hole equal in diameter to that of the cone and 20 to 30 feet deep may be made in a few hours, the time and depth depending of course upon the nature of the soil. The whole area upon which the structure is to be erected is thus treated, the holes being 5 to 6 feet apart between centers; and the result is the compression of the soil between the holes to an extent governed by the diameter and distance between them.

After the holes have thus been made, they are gradually filled with a concrete made of broken stone or cinder and hydraulic lime or cement. The concrete is thrown in in shallow layers, and pounded by allowing a spherical weight of about 2,000 pounds to drop from about the same height as that from which the cone was dropped. The effect of this procedure is to drive the more liquid portion of the concrete into the walls of the pits, and thus, when the latter are filled and the concrete has become hard, the foundation consists not only of the buried pillars of stone and cement, but also of the compressed earth partly charged with cement.

This method of making foundations has been used with much success in various portions of Paris, some of the locations being considered very difficult, owing to the soft nature of the soil; and the system is now being used to prepare the ground for the erection of some of the buildings for the exposition of 1900.

The effect of the pounding of the earth is said not to extend to sufficient distance to disturb adjacent structures, and in a number of cases the method has been used in the immediate vicinity of old and weak buildings without apparent injury.

It is possible that this system of compression may be of service in many locations where the load is not too great, and it appears to be of especial applicability to foundations for temporary structures, avoiding the necessity of much digging.

The Entropy Diagram and its Applications.

THE modern science of thermodynamics is becoming more and more freely applied in practical operations, and a working familiarity with its methods and applications may be said to be a necessity for those who desire to study intelligently the transformations between heat and work in engines of various forms.

In many instances, however, the theoretical discussions of the subject are so burdened with elaborate mathematics and so far removed from practical working application that the practising engineer finds small satisfaction in them. A very valuable series of articles upon the subject of the practical application of the entropy diagram has appeared in the issues of the *Revue de Mécanique* from January to June of this year, from the pen of Professor Boulvin, of the University of Ghent, who presents the subject with a minimum of mathematics, and shows very clearly how the method may be practically applied with ease.

After explaining the fundamental principles involved and the relation between the principle of Carnot and the entropy diagram, or *theta-phi* diagram, as its originator, Mr. Macfarlane Gray, has called it, Professor Boulvin proceeds first to apply the diagram to the investigation of a gas engine of the Otto type, taking his data from a test made by Prof. Capper on a 7-h. p. Otto-Crossley engine and constructing the entropy diagram from the indicator diagrams and other data of the test. He then passes to the more involved questions of vapors of various kinds, both saturated and superheated, with numerous diagrams showing the practical application of the principles.

The last article is devoted to the discussion of the entropy diagram as applied to the steam engine, and a practical case is fully worked out in a thorough and lucid manner. In closing, Professor Boulvin shows how the diagram may be applied to the steam turbine, and demonstrates that the impulses upon the successive wheels or vanes result in practically the same effect as that of the pressure of steam upon a piston in a cylinder.

It is gratifying to find so clear and practical a series of papers upon a subject so easy to obscure, and we again congratulate the author upon the manner in which he has handled it.

The Bouzey Dam Disaster.

THE terrible disaster of the failure of the Bouzey dam, in which eighty-four lives were lost and a vast amount of property ruined, has been discussed in many publications, but the recent report of the criminal proceedings before the *tribunal correctionnel d'Epinal* has reopened the subject, and M. A. Dumas reviews not only the judicial proceedings, but also the engineering evidence which the investigation has brought out. From his papers in the issues of *Le Génie Civil* for July 10, 17, and 24 we condense the salient points.

The hearing was the occasion for the exercise of much able legal and technical work, and the charge of homicidal negligence which had been brought against the department engineers and inspectors of the dam was finally dismissed. Upon the justice of this decision M. Dumas refrains from commenting, but, instead, reviews the testimony on his own account.

The testimony of the experts shows the following causes for the disaster:

1. Defective foundations.
2. Poor quality of materials.
3. Extreme narrowness of section.
4. Defective horizontal plan.
5. Defects in the repairs executed in 1888.
6. Carrying an unnecessarily high water-level in the reservoir.
7. Insufficient inspection service.

The first five of these points were known—to some at least—several years before the disaster, as the yielding which led to the repairs and reinforcement in 1888 revealed a deformation in portions of the dam as well as imperfections in the foundations and material of the original structure.

The materials were known to be of only moderate quality, from tests made at the time the dam was built, but the desire to use the stone and sand found in the vicinity overruled the question of quality. Had this fact been met by a corresponding increase in dimensions, there would have been less cause for criticism, but, as a matter of fact, the thickness of the middle portion of the dam was made even less than the best of materials would have warranted. It was shown that the line of pressure in the masonry passed considerably without the middle third of the profile when the reservoir was filled, thus subjecting the inner wall to a tension which would have severely tested the resisting power of the best masonry. The reinforcement added to the dam at its base in 1888, while materially strengthening the whole structure against the slippage which then threatened it, was not carried high enough to modify the position of the pressure line at the thin portion, and it was to this very weak section undoubtedly that the disaster was mainly due.

So far as inspection is concerned, it was shown that the rupture was not preceded by preliminary indications of weakness sufficient to warrant serious apprehensions. On the contrary, the fears which had been raised by the deflections noticed several years before had been thoroughly allayed by the cessation of further motion, and the confidence of the department engineers in the stability of the structure seems to have been fully restored at the time of the failure.

An examination of the ruins of the dam made by a special commission of experts consisting of MM. Brüll, Fleury, and Langlois, supplemented by an inspection by M. Maurice Lévy, gave indications that the rupture occurred both by cracking under tension and by shearing, the latter probably having taken place after the first breach had been made. Attempts were made to show that the dam had been weakened by the effect of the preceding severe winter, but no satisfactory evidence could be found to sustain this view.

While the charge of criminal negligence against the department engineers and inspectors was held not to have been made out, the responsibility for the failure was morally placed upon the general council of the *Ponts et Chaussées*, since the plans for the dam were submitted to and fully approved by it. A proper examination of the section adopted, and of the details of construction, should have revealed in advance the essential weakness of the design, and the fearful results which followed cannot be considered as other than the natural effects of perfectly obvious causes, which should have been so apparent as to be entirely preventable, either at the original time of construction or at the time of the subsequent repairs.

Military Bicycles.

EARLY in the history of the bicycle its possible value in warfare was perceived by various tacticians, but mechanical difficulties, especially in regard to weight and portability, have delayed its practical introduction. Of late, however, we have heard more of the real value of the wheel, especially as a means of enabling reconnoitring parties to scour the country in advance of a main column. The efficiency of the wheel for such service has been fully demonstrated in the United States by the very successful run of Lieutenant Moss and his party from Fort Missoula, in Montana, to St. Louis,—a distance of 1,900 miles over very rough country.

In the issue of *Stahl und Eisen* for July 15 is given some account of the experiments which have been made with military bicycles by some of the continental powers, from which it appears that in nearly every army there is at least one bicycle company under training for this special service.

The first country to appreciate the importance of the subject was France, and at the present time there are 25 French bicycle companies, 7 of which consist of 5 officers, 29 non-commissioned officers, and 170 men each. The remaining 18 contain 3 officers, 16 non-commissioned officers, and 98 men each, the whole forming the eighteenth army corps. These are all mounted on the Gérard portable wheel, which can be disconnected in one minute, the two wheels being placed together and the whole slung upon the soldier's back for transportation over country in which riding is impossible. The weight of the Gérard military wheel is 27½ pounds, which is light enough for the heavy nature of the service.

Bicycle companies are also in drill in the armies of Austria, Prussia, Saxony, and Bavaria, and in all cases the opinion of military men is growing more and more favorable toward the mechanical steed. The matter of forage, one of the most difficult problems of army maintenance, is solved by the introduction of the wheel. The military powers are becoming more convinced of the controlling importance of the infantry, and now regard cavalry as of value mainly for its ability to make rapid advances; but infantry regiments mounted on bicycles may soon render cavalry obsolete.

The wheel used in the Prussian army, and shown in *Stahl und Eisen*, is made with the drop and saddle so low that both feet can be placed on the ground without dismounting; thus the soldier can stand with the bicycle between his legs and handle his musket freely, being at the same time ready for instant motion. Most of these wheels are provided with pneumatic tires, although in the Prussian service cushion-tires are also used, as it is feared that in actual service many wheels would otherwise be disabled through punctures.

In France Captain Charrollois has designed an apparatus for enabling telephone wires to be rapidly laid from a bicycle, and quadricycle ambulances have been made for field hospital use in several countries, including the United States.

The severe tests to which the various form of military bicycles are being put in times of peace will probably result in the development of a wheel especially adapted to the service.

For this purpose the tire should be practically non-puncturable, and all parts should be as strong as possible; yet the whole affair must be readily portable upon the shoulders of the rider, without impeding him excessively in getting across a plowed field or a rocky valley.

The Development of Hydraulic Power.

THE influence which the introduction of electric transmission has exercised upon the development of hitherto unused water powers has been noted repeatedly in these pages, but its growing importance is made apparent by the frequent references to new plants and applications. This is true in various countries, and in *La Revue Technique* for August 25, and in the *Zeitschr. des Ver. deutscher Ingenieure* for August 14, the subject is brought out by reference to new or contemplated installations.

In the former journal M. Durandy calls attention to the resources of the Alpine departments of France. In the departments of Savoie, Haute-Savoie, and Isère the power of the mountain streams has been utilized to a large extent already, and a company has now been formed to develop the water power of the Maritime Alps in a systematic manner.

Of the sites controlled by the company there are three of especial importance,—namely, the fall of Mesela, the fall of Plan du Var, and the fall of Cians. The first two of these utilize the water of the Var, furnishing about 700 cubic feet per second, with a fall of about 38 feet in the first case and 70 feet in the second.

Taking into account the various losses, it is estimated that these two plants will develop 2,000 and 4,000 h. p. respectively, but the construction of the plants will involve some tunnelling in order to take advantage of the sudden curves of the stream through its rocky channel, and obtain the necessary fall within a short length.

The third site is one of reverse conditions, the fall being great and the volume small. By the construction of a short canal a fall of 400 meters, or about 1,300 feet, can readily be obtained, but the volume of water available is only about 28 cubic feet per second, from which, however, at such a head, an effective development of 3,200 h. p. can be obtained.

None of these installations is as yet constructed, but the first is now under way, and is expected to be completed within a year, while the others will follow as the demand for power warrants. It is expected that these new developments of hydraulic power will be of increasing importance, because of the neighborhood to the Mediterranean ports, thus bringing manufacturing and water transportation in close proximity.

The article in the *Zeitschr. des Ver. deutscher Ingenieure* is by the well-known electrician, Herr Uppenborn, and describes some of the new hydraulic and electric plants already completed and in operation in various parts of Germany and Switzerland.

Among these may be mentioned the power plant at Hollriegelsgreuth on the Isar above Munich, where a volume of about 2,000 cubic feet per second is given a fall of nearly 10 feet by a dam, more than 2,000 h. p. being developed for electric lighting and power in Munich.

In Switzerland, the hydraulic plant at La Goule, in the Bernese Jura, is of interest from the fact that the water of the Doubs is conducted through a tunnel, and then through a closed pipe 7 feet 4¼ inches in diameter, giving an effective head of 82 feet capable of developing about 4,000 h. p., although the turbines as yet in use give only 2,000 h. p. Current is furnished from this station, both for lighting and power. Some data are given as to charges, which would be more valuable if they were more comprehensive. For motors of 2 to 12 h. p., the price is about $50 per horse power per year, but special terms are made for larger powers. Current is distributed within a radius of 10 to 15 miles, the loss in transmission averaging about 10 per cent. for lighting, and 20 per cent. for power.

Another recent Swiss power plant is that at Zufikon-Bremgarten, where the power of the Reuss is utilized by taking advantage of the fact that the river makes a bend of nearly 180°, and that there is a difference in level of nearly 18 feet between two points in the stream which are thus brought so near to each other that a short canal through the intervening neck of land enables the water to be brought across. A canal less than quarter of a mile long thus permits the utilization of about 1,300 h. p., of which nearly 800 h. p. is distributed in small motors in Zurich, 240 h. p. is used in the large flouring mills of that city, and the rest is used for lighting purposes.

A New Bridge at Berne.

THE city of Berne is situated in a loop of the river Aar, upon a sort of rocky promontory which it has long since outgrown, so that upon the opposite banks of the stream a number of suburbs form part of the present city. Several bridges have been thrown across the river to facilitate communication with the outlying portions, the best known of these being the stone arch of the Nydeck bridge, of one hundred and forty-seven feet span. Among the other bridges may be mentioned the Kirchenfeldbrücke, connecting the cathedral place with the so-called Helvetia Platz, and the high iron-arched railroad bridge. The most recent structure is the new Kornhausbrücke, to which reference has already been made in these pages and, which will not be completed until the end of next year.

A competition has just been closed for plans for still another bridge across the Aar, to connect the western end of the promontory with the suburb known as the Lorraine quarter, and the leading designs re given in the issues of the *Schweizersche Bauzeitung* for August 14, 21, and 8, and September 4, with interesting deails.

The first prize of eight thousand francs vas awarded to a design consisting of a nain stone arch spanning the river, with tone viaduct approaches. Owing to the teepness of the banks, the rise of the arch s greater than the half-span, and the form f arch curve is made to conform almost xactly to that of the equilibrium curve or the conditions involved. The span is o meters, and the rise 35 meters, or 197 eet by 115 feet, the roadway being carried pon small spandrel arches supported by lender piers reaching down to the main rch ring. The whole outline of the equiibrated arch is thus revealed, there being o solid backing, as none is necessary with his strictly correct solution of the probem. The drawings show the beauty of his practical application of the theoretical rinciples of arch-construction. While dmitting the excellence of some of the ther designs shown, we cannot refrain rom congratulating the judges on their visdom, and the engineers (MM. Robert Moser and Gustav Mantel, of Zurich) on heir ability.

It is to be hoped that this most admirble design will be executed in strict conormity to the original plans now shown, nd that another ornament of modern ridge-construction will thus be added to he capital of Switzerland.

The Simplon Tunnel.

NUMEROUS projects have been proposed or the construction of a tunnel through he Alps at the Simplon pass, but it was ot until 1895 that the Swiss and Italian overnments arrived at a satisfactory greement for the prosecution of the ndertaking.

The plan now adopted is that of the Simplon-Jura Railway, and involves a tunnel 6.7 miles long; the scheme is unique n some of its details. As at first constructed, the tunnel is to be single track, but there is to be an auxiliary tunnel parallel to the main one, connected to it at intervals by cross galleries. The second tunnel is to be used for ventilating purposes in connection with powerful fans, and, if the demands of travel require a double track, the second tunnel can be enlarged for the purpose. The distance between the two tunnels is to be 56 feet from center to center, and the connecting passages are to be about 650 feet apart.

The present estimates place the cost of the tunnel at fifteen million dollars, and the time for completion at five and a half years. Since the new tunnel will be at a decidedly lower altitude than any of the other Alpine tunnels, it is expected that a much higher rate of speed can be maintained on the road. The maximum altitude of the Simplon tunnel will be only 2,300 feet above the sea, while the elevation of the St. Gothard is 3,800 feet, the Mont Cenis 4,240 feet, and the Arlberg 4,300 feet.

The Simplon tunnel will provide a much-needed railway communication between French Switzerland and Italy, placing the upper Rhone valley in the through line of travel, and cannot fail to be of advantage to the many beautiful towns about the Lake of Geneva.

The Exposition of 1900.

IT is the proper thing now for every great exposition to have its side shows, and the "*rue de Caire*" of the Paris exposition of 1889 was undoubtedly the prototype of the various "streets" and midways which have appeared since then. In the coming exposition of 1900 it is proposed to vary this theme by having a "*rue de Tokio,*" of which some description is given in *La Revue Technique.* This street is to be a veritable reproduction of a Japanese thoroughfare, containing shops in which wares are to be not only sold, but manufactured, and where all the dainty industries of the Japanese may be seen as at home. A Buddhist temple is to be constructed, the service to be conducted in the same manner as in Japan, while in a beautiful garden beyond will be found restaurants, theatres, dancing-halls, and all the shows which the traveller to the flowery isles expects to find. If the idea is properly and completely carried out, a most attractive display may be made, but it will require much patient work and sharp watching to keep such an exhibit from degenerating into a mere money-making scheme of little interest and no real value.

Bleaching by Electricity.

THE increasing number of applications of electricity to chemical and technological industries cannot fail to attract the attention of all who are interested in the commercial development of industrial operations. Among these applications one of the more recently successful is that of substituting electrical decomposition of chlorine salts for bleaching purposes for the older chlorid of lime method.

An article in the *Moniteur Industriel* for June 5 gives an account of the latest improvements in electric bleaching, from which we condense the essential points.

In the decomposition of a solution of sea salt by the electric current without the interposition of a diaphragm, the products obtained are chlorine and caustic soda, which immediately recombine to form hypochlorite of soda, the active agent in a bleaching solution. But at the same time with this principal reaction there exist secondary reactions which reduce the useful effect of the principal, these consisting mainly of the formation of chlorate, and the reduction of a portion of the hypochlorite to chlorid of sodium. Another source of difficulty lies in the electrodes. If these are of carbon, the rapid wasting away is a source of loss, and, furthermore, fouls the bath, necessitating frequent filtration. Platinum electrodes have been suggested, but the expense adds to the original cost of the plant, increasing the fixed charges.

The difficulty of the electrodes has been overcome by Dr. Kellner, who has devised an electrode consisting of a sheet of hard rubber armed with a number of platinum points like the bristles of a brush, and by the use of these terminals, and with the employment of special care as to the strength of current and temperature of bath, he has succeeded in obtaining electrolytically solutions containing about one per cent. of hypochlorite, which is a degree of concentration more than sufficient for all practical purposes.

A number of experiments have demonstrated that electrolytic solutions can be successfully employed in the bleaching of paper pulp, cotton, jute, flax, etc., with less injury to the material than occurs with bleaching powder, and that, with proper skill in installation and operation, a decided economy is also effected.

As in most electrical industries, the cost of the power is an important item in the operating expense. When hydraulic power is available, estimated in France as costing about $25 per h. p. per annum in 100-h. p. units, the electrical bleaching is decidedly cheaper than the older methods, and, even when steam power is required, estimated at $70 per h. p. per annum, there is an appreciable saving in cost, not taking into account the greater uniformity of results and reduced injury to the product.

Physiological Action of X Rays.

THERE has been some talk about the injurious action to the system of a prolonged exposure to the action of the Röntgen rays, and, according to a note communicated to the French Academy by M. dArsonval, on the part of MM. Seguy and Quenisset, a violent palpitation of the heart is caused when the exposure is very long. M. Seguy observed this effect in a number of instances, and M. Quenisset caused a subject to be exposed to the rays for a length of time sufficient to enable their therapeutic action to be observed. These latter experiments produced a great oppression in the region of the heart, followed by violent and irregular palpitations, which became almost insupportable when the rays traversed the chest. When, however, a thick plate of metal was placed so as to intercept the rays in the vicinity of the heart, relief followed, and the results of these experiments indicate that this precaution should always be observed when the exposure is prolonged.

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Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila., Pa.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
California Architect. *m.* San Francisco, Cal
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m.* New York.
Chautauquan. *m.* Meadville, Pa
Colliery Engineer. *m.* Scranton, Pa.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris
Contemporary Review. *m.* London
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
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Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York
Electrical Engineering. *m.* Chicago, Ill
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* New York.
Electricity. *w.* London.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Elektrotechniker. *b-m.* Vienna.
Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Engineer. *s-m.* New York.
Engineer. *w.* London.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, Tenn.

Engineering and Mining Journal. *w.* N. Y.
Engineering Magazine. *m.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester, The. *bi-m.* May's Landing, N.J.
Fortnightly Review. *m.* London.
Forum. *m.* New York.
Foundry. *m.* Detroit, Mich.
Garden and Forest. *w.* New York.
Gas Engineers' Mag. *m.* Birmingham, Eng.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glasers Ann. für Gewerbe & Bauwesen. *s-m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trade Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
Journal Assoc. Eng. Society. *m.* St. Louis, Mo.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q* New London, Conn.
Journal Political Economy. *q.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Journal of the Society of Arts. *w.* London.
Journal of the Western Soc. of Eng. *b-m.* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kan.
Locomotive Engineering. *m.* New York.
Machinery. *m.* New York.
Machinery. *m.* London.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London
McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
Mining and Sci. Press. *w.* San Francisco, Cal
Mining Industry and Review. *w.* Denver, Col.
Mining Journal. *w.* London.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. Stuttgart
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* Paris.
Nature. *w.* London.
New Science Review. *qr.* New York.
Nineteenth Century. *m.* London.
North American Review. *m.* New York
Oesterr. Monatsschr. für den Oeff. Baudienst. *m.* Vienna.
Oesterr. Zeitschrift für Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *q.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill
Railway Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revue Technique. *b-m.* Paris.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York
Sanitary Record. *m.* London.
School of Mines Quarterly. New York
Schweitzerisches Bauzeitung. *w.* Zurich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York
Scientific Am. Supplement. *w.* New York
Scientific Machinist. *s-m.* Cleveland,
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J.
Stone. *m.* Chicago, Ill.
Street Railway Journal. *m.* New York
Street Railway Review. *m.* Chicago, Ill
Technology Quarterly. Boston, Mass.
Tradesman. *s-m.* Chattanooga, Tenn
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill.
Western Railway Club, Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Zeitschrift für Lokomotivführer. *m.* Hannover.
Zeitschrift für Maschinenbau & Schlosserei, Berlin.
Zeitschrift des Oesterr. Ing. und Arch. Ver. *w.* Vienna.
Zeitschrift des Ver. Deutscher Ingenieure. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle, a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.
Zeitschrift für Instrumentenkunde. *m.* Berlin.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Clinic Building.

A New Clinic for Philadelphia. Description with plans of what is believed to be the finest and largest clinical amphitheatre either in the United States or Europe. Describes in detail the warming and ventilation of the building. 3000 w. Eng Rec—Sept. 4, 1897. No. 15042.

Club House.

The Hollywood Inn. Illustrated description of a workingman's club, at Yonkers, N. Y. 800 w. Harper's Wk—Sept. 18, 1897. No. 15354.

Colombo.

The Victoria Buildings, Colombo. Description, with illustration, of new buildings of architectural pretensions, recently erected. 2000 w. Ind Engng—Aug. 28, 1897. No. 15603 D.

Co-operative Residences.

The Coleman-Stuckert System of Co-operative Residences. Florence May Gardiner. Describes the model homes for the middle classes as planned by Mrs. Coleman-Stuckert. Ill. 1800 w. San Rec—Sept. 17, 1897. Serial. 1st part. No. 15539 A.

Ferry House.

A Handsome Metal Ferry House. Illustrated description of the building erected by the Pennsylvania Railroad Company at Twenty-third street and Eleventh avenue, New York. It is of iron construction and covered with sheet metal inside and out. 900 w. Met Work—Sept. 11, 1897. No. 15218.

Library.

Chicago Public Library. Illustrated description of a fine building of classic style. 1600 w. Harper's Wk—Sept. 18, 1897. No. 15355.

Museum.

The Competition for the Technical Museum of Northern Bohemia at Reichenberg. (Zum Wettbewerb des Nordböhmischen Gewerbemuseums in Reichenberg.) A discussion, with plans, elevations and sections, of the two most important designs submitted. 5000 w. Wiener Bauindustrie Zeitung—July 15, 1897. No. 15193 B.

Roofing.

Slate and Copper Roofing in Fireproof Buildings. William Neubecker. Illustrated description of the best methods to follow in the construction of these roofings. 1200 w. Met Work—Sept. 4, 1897. No. 15069.

Spring House.

Competitive Designs for Buildings for the Giesshübl Springs. (Entwurf für einen "Quellentempel" in Giesshübl.) Description and phototype illustrations of competitive drawings for ornate buildings over the medicinal springs at Giesshübl. 3 plates. 1200 w. Wiener Bauindustrie Zeitung—July 1, 1897. No. 15192 B.

Town House.

The Modern Town House. A criticism of the houses of London in general, with brief description of the house built by Mr. Barnato. 1600 w. Ill Car & Build—Sept. 3, 1897. No. 15295 A.

Theatre.

The West End Theatre in Berlin. (Das Theater des Westens in Berlin.) Description of this handsome new theatre in the fashionable quarter of Berlin, with plans and phototypes of the exterior and interior. 4000 w. 4 plates. Wiener Bauindustrie Zeitung—June 3, 1897. No. 15191 B.

Warehouses.

The Grain Warehouses of Braïla and Galatz. (Les Silos des Ports de Braïla et de Galatz.) Describing the new and important grain warehouses in these two important Danube ports in Roumania. 1500 w. 1 plate. Le Génie Civil —May 15, 1897. No. 15140 D.

HEATING AND VENTILATION.

Clinic.

Ventilation of the Polhemus Memorial Clinic. Illustrated description of a ventilating plant of particular interest on account of the height, number of occupants, vitiating elements, and that the construction was such that flues in the outside wall were in no case possible. 2500 w. Eng Rec—Sept. 25, 1897. No. 15586.

Combination.

Combination Heating and Cooling Systems. Suggestions for a combination system to be used for cooling in the summer and heating in the winter. 2000 w. Heat & Ven—Sept. 15, 1897. No. 15449.

Furnace Heating.

An Aspirating Furnace Heating System. Explains the nature of the ground, and the arrangements of the buildings of the First Universalist Society, of Buffalo, N. Y., with the interesting features of the heating system. 1800 w. Met Work—Sept. 18, 1897. No. 15418.

Hot-Water System.

A Single-Pipe System of Hot-Water Heating. Illustrated description of heating system in the residence of H. E. Baumann, of Charlotte, Mich., which is said to be unusually effective and economical, 700 w. Met Work—Sept. 18, 1897. No. 15417.

Local Ventilation.

Local Ventilation of Water Closets and Other Plumbing Fixtures. James J. Lawler. The importance of giving attention to this subject especially in the home, with illustration as a suggestion of what can be done. 1500 w. Dom Engng—Sept., 1897. Serial. 1st part. No. 15501 C.

School.

Heating and Ventilation of the Twenty-third Ward Grammar School, New York City. Illustrated detailed description. 1300 w. Heat & Ven—Sept. 15, 1897. No. 15448.

Steam Heating.

Starting Up a Steam-Heating Plant. W. H. Wakeman. Calling attention of the inexperienced to points needing examination before the plant is started. 900 w. Am Mach—Sept. 30, 1897. No. 15626.

Steam-Heating Apparatus in a Country Residence. Illustrated description of the heating arrangements on "Roundtop Farm," the country seat of F. P. Olcott, near Bernardsville, N. J. 600 w. Heat & Ven—Sept. 15, 1897. No. 15450.

LANDSCAPE GARDENING.

Country Places.

Harmony in Small Country Places. Editorial on the importance of harmony of general effect, with suggestions. 1500 w. Gar & For—Sept. 1, 1897. No. 15001.

Flowers.

Wild Flowers of Early September. M. G. Van Rensselaer. Interesting review of the wild flowers of this season, and their location. 1700 w. Gar & For—Sept. 15, 1897. No. 15360.

Frost.

Some Facts About Frost Prevention. M. G. Kams. An account of the frost prevention methods used in France, with explanation of how they protect. 1100 w. Gar & For—Sept. 15, 1897. No. 15361.

Native Plants.

Native Plants for Ornamental Planting. Editorial suggesting the use of native supplies for the adornment of small country places, showing that greater harmony will result. 1500 w. Gar & For—Sept. 8, 1897. No. 15232.

The Improving of Native Plants. Thomas Meehan. Tells of a collection of native plants made in 1804 or 5, many of which the Indians used as food, and suggests the study, and cultivation of plants with this end in view. 1000 w. Gar & For—Sept. 15, 1897. No. 15359.

Parks.

How Boston Has Systematized its Parks. Sylvester Baxter. A description of the system which comprises a series of public spaces, related to each other, and each possessing a marked individuality. Highest praise is given the work. 2200 w. Century Mag—Oct., 1897. No. 15642 D.

Small Parks and Public-School Play-Grounds. Jacob A. Riis. Discusses the movement to give parks and play-grounds to New York City, giving map of existing and proposed parks. 2200 w. Harper's Wk—Sept. 11, 1897. No. 15026.

Statuary and Fittings in Our Public Parks and Gardens. Reginald Bloomfield. From a paper read at the Arts and Crafts Exhibition. A criticism of the fittings and ornaments in English public parks. 900 w. Brit Arch—Sept. 10, 1897. No. 15499 A.

Tree Planting.

What Can Be Done in Nine Years. Mary C. Robbins. Showing how a small place was changed from desolation to beauty in a few years. 2000 w. Gar & For—Sept. 8, 1897. No. 15233.

PLUMBING AND GASFITTING.

Conveniences.

Public Conveniences in New York City. Illustrated description of conveniences located beneath the sidewalk. 1300 w. Eng Rec—Sept. 18, 1897. No. 15468.

Country Residence.

Water Supply, Plumbing and Drainage System for a Country House. Illustrated description of work carried out at the country residence of Perry Tiffany, at Westbury, Long Island. 2000 w. Eng Rec—Aug. 28, 1897. No. 14981.

Hot-Water Plumbing.

Hot-Water Plumbing System in a Plainfield Residence. An unusual distribution required to supply four bath-rooms on opposite sides of the house in the upper stories, beside toilet room and the usual kitchen and laundry fixtures. Ill. 700 w. Eng Rec—Sept. 11, 1897. No. 15331.

Plumbing.

Plumbing on the Pacific Coast J. L. E. Firmin. A report of methods used in San Francisco, with comparison with eastern practice. 2500 w. Dom Engng—Sept., 1897. Serial. 1st part. No. 15500 C.

Plumbing Regulations.

New York City Amended Plumbing Regulations. Full text of the regulations recently adopted by the New York Building Department. 6000 w. San Plumb—Sept. 15, 1897. No. 15503.

Sanitary Progress.

The Influence of the National Association of Master Plumbers and its Results. W. F. Taaffe. Reviews the results of the past fifteen years. 1800 w. San Plumb—Sept. 15, 1897. No. 15502.

Siphons.

Something About the Siphon. Paul Plimton. An explanation of the principle upon which the siphon acts, with illustrations of its application, &c. 1200 w. San Plumb—Sept. 1, 1897. No. 15005.

MISCELLANY.

Church Restoration.

The Restoration of Ancient Churches. From the *Church Times*. Suggestions and precautions given in the hope that they may assist in the preservation of what is left of good old work. 3000 w. Arch Lond—Sept. 10, 1897. No. 15447 A.

Columbia Library.

Architecture and Mural Painting. Charles H. Coffin. Brief description with illustrations of interior of Columbia College library, and description of the mural paintings of the Art Gallery of Bowdoin College. 1600 w. Harper's Wk.—Sept. 25, 1897. No. 15506.

Competitions.

Competitions. Barr Ferree. The first of a series of papers inquiring into the cause of competitions not turning out fairly, and studying the proposed remedies. The present number is introductory. Am Arch—Sept. 4, 1897. Serial. 1st part. No. 15226.

The Harrisburg Competition. A Record. The particulars relating to the competition for the selection of an architect for a new Capitol building, at Harrisburg, Pa., and the rejection of the report of the Board of Experts, with editorial comment. 6800 w. Arch & Build—Sept. 18, 1897. No. 15439.

The Reasonable Principles of Architectural Competition. Robert D. Andrews. Considers the four issues of importance to be first, the legal validity of the contract; second, the financial considerations; third, other considerations; fourth, demands regarding cost and accomodation, and discusses these points. 2500 w. Br Build—Sept., 1897. No. 15616 C.

Crystal Palace.

The Crystal Palace. Illustrated description of the beautiful, interesting and educational features of this institution. 5000 w. Ill Car & Build—Sept. 3, 1897, No. 15296 A.

Exhibition.

The Stockholm Exhibition. Describes the exhibition, giving illustration of grounds, and high praise of the buildings and exhibits. 1800 w. Sci Am Sup—Sept. 4, 1897. No. 15011.

The Preliminary Work of the Exposition. (Les Premiers Travaux de l'Exposition.) Giving illustrations of the present condition of the work on the Champs-Elysées and notes concerning the general progress of the various portions of the Paris exposition of 1900. 3000 w. Le Génie Civil—June 5, 1897. No. 15146 D.

A Visit to the Works of the Exposition. (Une Visite aux Chantiers de l'Exposition.) Describing the present condition of the work upon the Paris exposition of 1900. 1800 w. La Revue Technique—August 25, 1897. No. 15124 D.

Fireproof Buildings.

Can Buildings Be Made Fireproof? Corydon T. Purdy. Relates in brief the incident of the Pittsburg fire, describes the important characteristics of the construction, and points out the lessons. Ill. 7500 w. Pro Am Soc of Civ Engs—Sept., 1897. No. 15538 F.

Details of Fire-proof Construction with Burned Clay. Peter B. Wight. Illustrations with description of hollow-tile building blocks used for partitions and the setting of them. 1600 w. Br Build—Sept., 1897. Serial. 1st part. No. 15617 C.

Floor Test.

Comparative Standard Fireproof Floor Test of the New York Building Department. Part first deals with the introductory history, conditions and purposes, previous tests, kilns, and requirements of building, loading, firing, and quenching, and the Rapp system. Ill. 4000 w. Eng Rec—Sept. 18, 1897. Serial. 1st part. No. 15467.

Friezes.

The Treatment of Friezes. Walter J. Pearce. Advocates the special designing for the position and gives suggestions for the work. Ill. 2000 w. Plumb & Dec—Sept. 1, 1897. No. 15283 A.

Pueblo Buildings.

House Building by Ritual. Cosmos Mindeleff. Illustrated description of the houses built by the pueblo tribes of Arizona and New Mexico, with account of their customs. 2000 w. Sci Am—Sept. 4, 1897. No. 15009.

Ireland.

The Ancient Architecture of Ireland: Considered Especially in Relation to Pre-conquest Buildings in England. Baldwin Brown. The first of a series of papers on early Irish buildings. Ill. 2800 w. Builder—Sept. 18, 1897. Serial. 1st part. No. 15591 A.

Iron Preservation.

The Preservation of Iron in Building Structures. H. C. Standage. Discusses the various pigments used, and why they fail; states that when glycerine is present the paint cannot be a perfect protection, and gives directions for forming a desirable covering. 4000 w. Builder—Sept. 11, 1897. No. 15490 A.

Iron Work.

Report Upon the Condition of the Iron Work in the Old United States Post-Office and Custom-House Building in the City of Chicago. The conclusion of the committee is that iron properly painted before being placed in a building, and reasonably protected from air and moisture, does not deteriorate to any serious extent. Discussion. 1200 w. Jour of W Soc of Engs—Aug., 1897. No. 15609 D.

Licensing.

Licensing Architects. A series of letters from architects giving their reasons for supporting or opposing the proposed movement, with a copy of the bill which has become a law in the State of Illinois. 4800 w. Am Arch—Sept. 18, 1897. No. 15451.

Monument.

The Monument to Colonel R. G. Shaw. Illustrated account, with criticism of this monument recently unveiled in Boston. 2700 w. Am Arch—Sept. 11, 1897. No. 15324.

Nottingham.

The Architecture of Our Large Provincial Towns. Description, with illustrations, of interesting English architectural work. 3000 w. Builder—Aug. 28, 1897. No. 15090 A.

Plastering.

A Plasterer on his Craft. Editorial review of a book by William Millar—A Practical Treatise on the Art and Craft of Plastering and Modelling. 2800 w. Builder—Sept. 18, 1897. No. 15590 A.

Roman Orders.

Roman Orders of Architecture. Cyrus K. Porter. Considers the important changes in the details made by the Roman architects and artisans in their treatment of the Tuscan and Grecian orders; also the use of the arch as practiced by the Romans. 6200 w. Stone—Sept., 1897. No. 15405 C.

St. Mary's, Oxford.

The Church of St. Mary the Virgin, Oxford. Review of Book by T. G. Jackson, dealing with its historical and architectural points of interest. Ill. 4800 w. Builder—Sept. 11, 1897. No. 15489 A.

CIVIL ENGINEERING.

BRIDGES.

Accident.

The Accident of the Adour Bridge. (L'Accident du Pont de l'Adour.) P. Crépy. A discussion of the failure of a plate girder bridge under a test load of two locomotives, just after completion. 2000 w. La Revue Technique—August 10, 1897. No. 15115 D.

Berne.

The Competition for a Bridge over the Aar between Berne and the Lorraine Suburb. (Der Wettbewerb eines Aare Ueberganges von der Stadt Bern nach dem Lorraine-quartier.) With reproductions of the prize-winning designs for this important structure. Four articles. Four plates. 7000 w. Schweizerische Bauzeitung—August 14, 21, 28, September 4, 1897. No. 15130 H.

Bridge Design.

Bridge Over Wissahickon Creek, Fairmount Park, Philadelphia. Joseph Wood Wagner. Description, with illustration, of a bridge of excellent design, and well suited to the location. 1200 w. Eng News—Sept. 9, 1897. No. 15269.

Bridge Painting.

Painting the Louisville and Jeffersonville Bridge. O. E. Selby. During the painting of this bridge by the company a careful record was kept of the cost of labor and materials for different parts of the work, and the purpose of the paper is to give an analysis of the results obtained and such data as may be of value. 2200 w. Pro Am Soc of Civ Engs—Sept., 1897. No. 15537 F.

Brooklyn Bridge.

See same title under Street and Electric Railways.

Cantilever.

The Francis Joseph Bridge across the Danube at Budapest. (Le Pont François Joseph sur le Danube à Budapest.) An illustrated description of this fine cantilever, with photographic views of the partially completed work and a plate of details. 4500 w. Le Génie Civil—May 8, 1897. No 15135 D.

Cleaning Iron.

Cleaning a Viaduct by the Sand Blast. Illustrated description of the test work under the direction of E. P. North, made on the One-hundred and fifty-fifth street viaduct, New York. 1800 w. Eng Rec—Sept. 25, 1897. No. 15584.

Cleaning Structural Iron by the Sand-Blast Preparatory to Painting. An account of experimental work being conducted by the Department of Public Works, on the 155th St viaduct in New York City, which has been attacked by rust. 1500 w. Eng News—Sept. 23, 1897. No. 15533.

The Sandblast for Structural Steel. Describes the work being done on the 155th St. viaduct, its effect upon the iron, and the treatment as a test of the best protective paint. 1700 w. Am Mach—Sept. 30, 1897. No. 15624.

Corrosion.

See same title under Mining and Metallurgy Iron and Steel.

Delaware Bridge.

Superstructure of the Delaware-River Bridge at Bridesburg, Philadelphia, for Pennsylvania and New Jersey R. R. Co. Paul L. Wolfel. Detailed description and account of erection, with illustration and short discussion. 4500 w. Pro Engs' Club of Phila—July-Sept., 1897. No. 15250 D.

Drawbridge.

Operating Machinery for the North Halsted Street Drawbridge, Chicago, Ill. Illustrated description of such details of this bridge as are deserving of especial mention. 1600 w. Eng News—Sept. 9, 1897. No. 15273.

The Hydraulic Installation of the Swing Bridge at the New Harbor at Lübeck. (Die Hydraulische Einrichtung für die Drehbrücke im Neuen Hafen zu Lübeck.) Giving a full description of the very complete hydraulic machinery for turning the swing bridge, with plate of detail drawings of accumulators. 2500 w. Zeitschr Ver Deutscher Ing—September 4, 1897. No. 15111 D.

Duluth-Superior Bridge.

Duluth-Superior Bridge. Illustrated description of this bridge which was built under special act of the American congress. 2200 w. Ry Rev—Sept. 4, 1897. No. 15216.

East River Bridge.

The Anchorages for the New East River Bridge. Drawings of the general details of the Brooklyn anchorage, with description. The New York anchorage will be mostly the same; the exceptions are noted. 2200 w. Eng News—Sept. 9, 1897. No. 15274.

Enlarging Bridge.

Enlarging the Covington and Cincinnati Suspension Bridge. H. L. Bridwell. Illustrated description of a difficult piece of engineering work, which has had to be carried on without interrupting traffic. 1200 w. R R Gaz—Sept. 17, 1897. No. 15412.

Harlem River Bridge.

The Willis Avenue Bridge Over the Harlem River, New York City. Elevation with brief description of bridge to be constructed. 700 w. Eng News—Sept. 23, 1897. No. 15532.

Niagara Bridge.

Test of the New Steel Bridge at Niagara. Diagrams of deflection under test load of 2300 tons are given, with information of test. 700 w. R R Gaz—Sept 3, 1897. No. 15031.

Paris.

The Alexander III Bridge. (Le Pont Alexandre III.) Illustrated description of this fine new single arch over the Seine, with perspective drawing, photographs of the present condition of the work, and plate of elevation and details. 5000 w. 1 plate. Le Génie Civil—June 26, 1897. No. 15155 D.

Pinion Brackets.

Improved Drawbridge Pinion Brackets. Illustrations of a steel pinion bracket recently designed by Mr. Roemheld, engineer of bridges, Chicago. 250 w. Eng Rec—Sept. 25, 1897. No. 15585.

Stephenson Bridge.

The Stephenson Bridge in Paris. Brief illustrated description of a single-span bridge which was thrown bodily across the line of the Northern Railway Co. 450 w. Engr, Lond—Sept. 3, 1897. No. 15343 A.

Versam Bridge.

The Versam Bridge. S. Berg. Illustrated description of construction of a three hinged arch bridge crossing a wild gorge. 900 w. Engr, Lond—Aug. 27, 1897. No. 15087 A.

Victoria Bridge.

The Victoria Bridge, Brisbane. Description with photographs of the bridge completed and in course of construction. 1000 w. Engr, Lond—Sept. 17, 1897. No. 15548 A.

CANALS, RIVERS AND HARBORS.

Canal.

Project for a Russian Ship Canal between Riga and Kherson. (Project für einen Russischen Seeschiffahrts-Canal Riga-Kherson.) A plan to connect the Black Sea with the Baltic by means of a ship canal in connection with the rivers Düna, Beresina and Dneiper. 1500 w. Zeitschr d Oesterr Ing u Arch Ver—August 13, 1897. No. 15127 B.

The Chicago Main Drainage Channel. J. F. Lewis. Geological evidences that the valley being opened for drainage, is connected with the processes and effects of the ice period, and is the renewing of a drainage direction which formerly existed. Also a brief description of the work on each section. Ill. 8800 w. Trans Am Inst of Min Engs—Sept., 1897. No. 15396 D.

The Improvement of the Waterway around Douay. (Derivation de la Scarpe Autour de Douai.) Describing the improvements in the connecting canal which unites the canals of Haute-Deule and Sensée, with profile, sections, and plans of locks. 4000 w. 1 plate. Le Génie Civil—June 19, 1897. No. 15154 D.

The New York State Canals Improvement. Part first treats of the purpose and nature of the improvements, giving table of contract prices for principal items of work, and profile from Buffalo to Albany. 2000 w. Eng News—Sept. 2, 1897. Serial. 1st part. No. 15018.

Central American Canals.

The Diplomacy of the United States in Regard to Central American Canals. James Gustavus Whiteley. Historical review of the interoceanic canal problem. 5500 w. N Am Rev—Sept., 1897. No. 14991 D.

Cherbourg.

The Reinforcement Works of the Forts of the Dyke of Cherbourg. (Travaux de Renforcement des Forts de la Digue de Cherbourg.) An illustrated account of this important piece of masonry construction. 2000 w. Le Génie Civil—May 22, 1897. No. 15143 D.

Dam.

The Failure of the Bouzey Dam. Editorial on the results of the official inquiry into the cause of the failure. 2000 w. Eng, Lond—Sept. 10, 1897. No. 15438 A.

The Failure of the Bouzey Dam. (Rupture de la Digue de Bouzey.) A. Dumas. A discussion of the testimony before the French Courts, showing the failure to have been due to defective design and construction. Three articles. 9000 w. Le Génie Civil—July 10, 17, 24, 1897. No. 15164 H.

The Use of Rolling Shutters in Movable Dams. (Emploi de Vannettes a Galets pour la fermeture des Barrages Mobiles.) Description of the Boulé improved movable dam, in which the sections are carried on rollers provided with ball bearings. 3000 w. Le Génie Civil—May 1, 1897. No. 15134 D.

Dikes.

The System of Protection of Corning, N. Y., from Floods in the Chemung River. Describes the location of the city and the earthen dykes used to confine the river, giving extracts from the specifications which explain the method of construction. Ill. 2500 w. Eng News—Sept. 2, 1897. No. 15014.

Floating Dock.

Floating Dock for San Paulo de Loanda. Gives illustrated description of a steel dock recently constructed by order of the Portuguese government. 1800 w. Engng—Sept. 10, 1897. No. 15459 A.

Haulage.

Electric Towage on Canals. The first of a series of articles on this subject, dealing with chain haulage boats. Ill. 2500 w. Engng—Aug. 27, 1897. Serial. 1st part. No. 15077 A.

Levees.

The Mississippi Levees and the Flood. Extracts from a letter by H. B. Richardson, chief state engineer of Louisiana, reviewing the experience with the levees during the recent flood. 2200 w. R R Gaz—Sept. 3, 1897. No. 15033.

Lighthouses.

An Account of the French Lighthouse System. (Die Entwicklung des Französischen Leuchtfeuerwesens.) Commenting most favorably upon the administration of the French lighthouse system, and describing in detail the arrangements of arc electric lights and Fresnel prisms. 2500 w. Zeitschr d Ver Deutscher Ing—August 28, 1897. No. 15110 D.

Lock.

A New Thames Lock. Describes the condition of the Thames, the improvements already made and their effects, as well as proposed improvements, &c. 2200 w. Engng—Sept. 10, 1897. No. 15463 A.

Ports.

The Rival Ports of Monte Video and Buenos Ayres. Deals mainly with Monte Video, the position of the port and the new works. Discusses also the competition of foreign nations with British trade. Report of the British Consul. 1700 w. Trans—Sept. 10, 1897. No. 15505 A.

Wharf Improvements.

Modern Wharf Improvements and Port Facilities. Foster Crowell. Contrasting the effects of private enterprise and those of political blight upon the water-fronts of typical Atlantic cities. Ill. 4500 w. Eng Mag—Oct., 1897. Serial. 1st part. No. 15631 B.

IRRIGATION.

Irrigating Dam.

The Hemet Irrigating Dam, Southern California. Particulars from a paper by James E. Schuyler read before the Technical Society of San Francisco. Illustrated description of an interesting piece of work. 900 w. Sci Am—Sept. 25, 1897. No. 15515.

India.

Irrigation in India. Russick Loul Roy. Discusses the need of improving the water supply for irrigation purposes, reviews the different districts, what has already been done and the results. 1600 w. Ind Engng—Aug. 14, 1897. No. 15285 D.

MISCELLANY.

Address.

The Civil Engineer and the University. George S. Morison. Abstract of an address delivered at the commencement exercises of Rensselaer Polytechnic Inst., Troy, N. Y. 3000 w. Eng Rec—Aug. 28, 1897. No. 14978.

Elasticity.

The Bending Elasticity of Bodies of Unequal Resistance. (Die Biegungselastizität bei Körpern von Ungleicher Festigkeit.) R. Latowsky. Discussing the shifting of the neutral axis in bodies of different resistance to extension and compression. 3000 w. Zeitschr d Ver Deutscher Ing—August 14, 1897. No. 15102 D.

Engineering Esthetics.

The Esthetic Treatment of Engineering Work. H. Heathcote Statham. Showing the undesirability of tawdry ornament in huge engineering structures. 3300 w. Eng Mag—Oct., 1897. No. 15638 B.

Madagascar.

Engineering in Madagascar. A brief account of the exploring operations of an expedition, the difficulties, accidents and delays. 1700 w. Eng, Lond—Aug. 27, 1897. No. 15085 A.

Materials.

The Chemistry of Materials of Engineering. A. H. Sexton. The first of a series of articles in which it is intended to discuss the chemistry of the various materials used in engineering, as far as this is of importance to the engineer. The present number begins the discussion of metallic materials. 2500 w. Prac Eng—Sept. 3, 1897. No. 15323 A.

Moment of Inertia.

Computation of Statical and Inertia Moments of Rolled Sections. (Zur Berechnung von Statischen und Trägheits-momenten von Walzprofilen.) Giving the formulas for a number of the more usual sections with tables of numerical values. 1500 w. Zeitschr d Ver Deutscher Ing—August 21, 1897. No. 15106 D.

Mortar.

Hardening and Deterioration of Lime Mortar H. K. Landis. An explanation of the changes that take place in mortars, the cause of deterioration, and other effects. 1500 w. Br Build—Sept., 1897. No. 15618 C.

Limestone Screenings in Cement Mortar. Arthur N. Talbot. Report of a series of tests made by request. Followed by discussion by Alfred Noble and others. 7500 w. Jour of W Soc of Engs—Aug., 1897. No. 15608 D.

Perronet.

The Life and Works of Perronet. (La Vie et les Travaux de Perronet.) An account of the unveiling of the statue of the great French engineer at Neuilly-sur-Seine, with a biographical notice, and illustrations of the Bridge of Neuilly and other of his works. 5000 w. Le Génie Civil—July 17, 1897. No. 15165 D.

Tunnel.

An Irish Channel Tunnel. James Barton. Brief paper read before the Federated Inst. of Min. Eng . Discusses the route desirable, the geological formation, and the ventilation. 1200 w. Col Guard—Sept. 17, 1897. No. 15561 A.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

British Trade.

Colonial Trade. Editorial discussion of blue-book recently issued by the Colonial Office. Considers some of the details of the report, with the general conclusion that the outlook is not very reassuring. 2300 w. Engng—Sept. 17, 1897. No. 15554 A.

China.

Opening for American Enterprise in China. A communication from Messrs. Taylor & Co., of Tientsin, speaking favorably of the opportunities for doing business in machinery and railway materials. 900 w. Cons Repts—Oct., 1897. No. 15390 D.

Commercial Museum.

An Asiatic Commercial Museum at San Francisco. A statement of the plan of John Barrett, United States Minister at Bangkok, Siam, for the establishment of a commercial museum for the purpose of bringing the immense markets of the Asian-Pacific into close touch with the United States, and furnishing a means of securing all kinds of information in regard to the far East. 1300 w. Bd of Trd Jour—Sept. 1897. No. 15544 A.

Commerce.

America's Progress in Manufactures. A study of the American Exports and Imports. 1400 w. Engng—Sept. 3, 1897. No. 15340 A.

British Treaties of Commerce Denounced. Translation of an article which appeared in the official paper of Belgium giving notice of an official communication denouncing the treaty of commerce and navigation concluded in 1862 between Belgium and Great Britain. 2000 w. Cons Repts—Oct., 1897. No. 15300 D.

Great Britain in Russia. Discusses the commercial and industrial warfare being waged, and the efforts of Great Britain to secure some of the trade which Germany is expected to lose. 800 w. Bradstreet's—Sept. 18, 1897. No. 15415.

Our Trade with Germany and Belgium. M. G. Mulhall. Discussion of the denunciation of the commercial treaties that existed between the countries named and Great Britain, with conclusions. 1700 w. Contemporary Rev—Sept., 1897. No. 15380 D.

Contracts.

The Right of Contract. F. B. Thurber. Discussion of whether regulation of trade is "restraint of trade" in a legal sense, and showing the danger of going too far in condemning aggregations of capital. 4000 w. N Am Rev—Sept., 1897. No. 14988 D.

Discriminating Duty.

Discriminating Duty Question Decided. Editorial comment on the opinion of Attorney-General McKenna on this question. Briefly states the specific questions upon which an interpretation was requested. 1300 w. Bradstreet's—Sept. 25, 1897. No. 15570.

Eastern Trade.

A New Business Alliance. Charles Moreau Harger. Calling attention to the new trade relations of the west and northwest, which are greatly affecting the traffic of the Atlantic slope in the United States. 1800 w. N Am Rev—Aug., 1897. No. 14992 D.

Formosa.

Japan and Formosa. Criticism of the Japanese administration of the island, with extracts from the report of the British consul regarding the trade and industries. 1700 w. Engng—Sept. 10, 1897. No. 15464 A.

Germany.

The Foreign Trade and Industries of Germany. Report in detail of the continued commercial and industrial prosperity, with suggestions for extending the American trade. 3800 w. Cons Repts—Oct., 1897. No. 15391 D.

Iron and Steel Industry.

See same title under Mining and Metallurgy, Iron and Steel.

Machinery Trade.

How to Develop Our Machinery Trade Abroad. Charles Davis. Discussion of the question with suggestions. 1500 w. Mach N Y—Sept., 1897. No. 15094.

Possible Outlets for American Machinery. A. F. Tennille. Call attention of American manufacturers to new enterprises, when opportunities for trade may be looked for. 600 w. Am Mach—Sept. 16, 1897. No. 15371.

Ports.

See same title under Marine Engineering.

Prices.

Comparative Prices of 108 Staple Articles, Raw and Manufactured Products, Cattle and Meats, at Quarterly and Monthly Intervals, Showing Fluctuations in Quotations from Oct. 1, 1893 to Sept. 1, 1897, Covering the Period of Recent Extreme Depression. Table. Bradstreet's—Sept. 11, 1897. No. 15319.

Protectionists.

Two Great Protectionists—Oliver Cromwell and Bishop Berkeley. Brief review of the protective measures advocated and enforced by the men named. 1200 w. Bul of Am Ir & St Assn—Sept. 10, 1897. No. 15320.

Shanghai.

The Trade of Shanghai in 1896. Facts and figures from the report of Consul-General Hannen, which show that Great Britain is still predominant in the carrying trade, and giving information of the exports and imports, and a short account of the growth of the industries. 2000 w. Engng—Sept. 3. 1897. No. 15339 A.

Tariff.

New Tariff Law of Venezuela. Consular report giving translation showing the difference between the old and new law. 500 w. Cons Repts—Oct., 1897. No. 15284 D.

New Tariff of Japan. Translation of the tariff law, regulating the customs dues to be levied in all cases wherein Japan is not bound by treaty stipulations. 5000 w. Cons Repts—Sept., 1897. No. 15058 D.

Tariff Changes and Customs Regulations. Reports of Norway, Netherlands, Belgium, Congo State, Germany, Tunis, Dahomey, Tahiti, Philippines, Italy, Hungary, Greece, United States, Venezuela, Peru, Liberia, Formosa, Newfoundland and Natal. 7800 w. Bd of Trd Jour—Sept., 1897. No. 15545 A.

Tariff of Canada, 1897. The text of the new Canadian tariff, with index, as issued from the Customs Department, Ottawa, June 29, 1897. 55000 w. Cons Repts—Oct., 1897. No. 15299 D.

CURRENCY AND FINANCE.

Coinage.

Spanish Experiments in Coinage. Henry Charles Lea. Historical account of the vicious currency legislation and its disastrous effects. 7000 w. Pop Sci M—Sept,, 1897. No. 14993 D.

Currency Legislation.

See same title under Governmental Control.

Foreign Coins.

Values of Foreign Coins and Currencies. Statements showing the value of foreign coins, as given by the Director of the United States Mint. 1500 w. Cons Repts—Sept., 1897. No. 15054 D.

Fiatism.

Lessons from History. W. M. Beckner. Experience of fiatism in New England. 2000 w. Mfrs Rec—Sept. 3, 1897. No. 15004.

Money.

The Stock of Money. Interesting information with tabular statements showing the monetary systems of population and the approximate stocks of money in the different countries of the world in the year 1896, and showing that the amount of money in the United States has more than kept pace with the growth of population. 2500 w. Bankers' Mag, Lond—Sept., 1897. No. 15240 D.

Precious Metals.

Production of the Precious Metals. An argument for the free coinage of silver by Francis B. Forbes, with reply by David L. Webster, and editorial comment. 6000 w. Gunton's Mag—Sept., 1897. No 15244 C.

Silver.

Sinking Silver. W. R. Lawson. A discussion of the silver problem and its effect on the various countries. 7000 w. Contemporary Rev—Sept., 1897. No. 15381 D.

GOVERNMENT CONTROL.

Currency Legislation.

The Adoption of the Gold Standard by Japan. Gives briefly the history of the evolution of the gold standard, with reasons for the change in Japan. 1000 w. Bankers' Mag, N Y—Sept., 1897. No. 15387 D.

The Need of Currency Legislation. James H. Eckels. Address before the Bankers' Assn. Thinks it imperative that legislative action establish, the fact that the United States is a gold-standard country. 4200 w. Bankers' Mag, N Y—Sept., 1897. No. 15385 D.

What Legislation is Needed in Respect to the Currency. John P. Branch. Recommends the adoption of the gold standard in the United States, gradual cancellation of government demand notes, and repeal of the tax on the circulation of banks. Presented before the American Bankers' Assn. 1500 w. Bankers' Mag, N Y—Sept., 1897. No. 15386 D.

Factory Legislation.

Factory Legislation for Women in the United States. Annie Marion MacLean. Reviews the development of the factory system, the beginning of the labor legislation, discusses the laws in the various States, the general results and needs of the future. Am Jour of Sociology—Sept., 1897. No. 15382 D.

Trusts.

Trusts in Austria. A copy of the bill recently introduced in the Reichstag for the supervision of trusts controlling the price of sugar, brandy, beer, oil from minerals, salt, and such articles of consumption as are subjected to an excise. 1500 w. Cons Repts—Sept., 1897. No. 15056 D.

LABOR.

Belgium.

Work and Wages in Belgium. W. H. T. A few particulars of the hours of labor and rate of wages of fitters, machinists, &c. 800 w. Prac Eng—Aug. 20, 1897. No. 14974 A.

Child Workers.

Little Girls in Factories. Florence Kelly. Suggestions from the chief inspector of factories and workshops for the State of Illinois, as to the best means of reducing child labor, and calling attention to the conditions that exist at present. 1500 w. Chau—Oct., 1897. No. 15607 C.

Coercion.

The Case of Allen v. Flood. From the London *Times*. A summary of the judges' opinions, the facts of the case and the point of law raised by the appeal are stated by one of the judges. 9500 w. Col Guard—Sept. 10, 1897. No. 15456 A.

Compensation Act.

The Workmen's Compensation Act. Charles H. Grinling. Considers the important change which has been brought about by the passing of this act. 4000 w. Bankers' Mag, Lond—Sept., 1897. No. 15241 D.

Labor Experiment.

A Successful Labor Experiment. A sketch of the "Committee of Forty one" and "Board of Conference" established by Commissioner George E. Waring in connection with the New York Department of Street Cleaning. 4000 w. Gunton's Mag—Sept., 1897. No. 15243 C.

Recent Socialistic Experiments. Gives report of various experiments, showing that nowhere has it yet been proved possible to successfully conduct a system which dispenses with the sentiment of self-interest. 2700 w. Gunton's Mag—Sept., 1897. No. 15245 C.

Labor Insurance.

Results of German Labor Insurance. Comment on report of J. C. Monaghan, United States Consul at Chemnitz, Germany, describing the results of the German experiment. 2000 w. Gunton's Mag—Sept., 1897. No. 15246 C.

Machine Mining.

Machine Mining and the Labor Question. W. E. Garforth. A letter of interest to those who are connected with collieries working thin seams of coal. Labor troubles in England. 2500 w. Col Guard—Sept. 10, 1897. No. 15457 A.

Occupations.

The Mortality Statistics of the Census in Relation to Occupations. William A. King. Reviews data given in the census report on mortality and vital statistics showing the influence of occupation upon the death rate. 5400 w. Am Jour of Sociology—Sept., 1897. No. 15383 D.

Organized Labor.

Organized Labor at Home and Abroad. Discusses the present conditions in England, the development both in the United Kingdom and the United States, &c. 900 w. Bradstreet's—Sept. 18, 1897. No. 15414.

Riot.

Miners' Riot Near Hazleton. Henry Edward Rood. An account of the trouble in the anthracite coal field, with some important events not before printed. 2800 w. Harper's Wk—Oct. 2, 1897. No. 15598.

The Riot at Lattimer, Pennsylvania. An account of the clash between the sheriff and his deputies, and a mob of coal strikers. 900 w. Harper's Wk—Sept. 25, 1897. No. 15507.

Strikes.

The Strikes and Picketing. Criticism of a book by W. J. Shaxby, recently published, with discussion of legal picketing. 1700 w. Jour Gas Lgt—Sept. 7, 1897. No. 15357 A.

The Buck-Jumping of Labor. W. H. Mallock. An interesting article showing that the power which labor is said to be acquiring, is of quite a different nature than what is popularly supposed and much more limited. 6000 w. Nineteenth Cent—Sept., 1897. No. 15297 D.

The Engineering Trades Dispute. Editorial discussion of the position as it affects both employers and employed. 1400 w. Prac Eng—Aug. 27, 1897. Serial. 1st part. No. 15092 A.

Unions.

Federations of Employers. Editorial on the causes that have made such a federation possible and right. 1500 w. Engng—Aug. 27, 1897. No. 15079 A.

Wages.

The Doctrine of Low Wages. Discusses the advocacy of low wages by the New York *Journal of Commerce*, combating the assumptions of that paper. 1500 w. Gunton's Mag—Sept., 1897. No. 15242 C.

Women Workers.

Are Women Hurting the Chances of Men in Business? Carroll D. Wright. Tabulated statements showing that the proportion of female workers is steadily increasing, and that while they to some extent take the place of men, more generally they are doing work formerly done by children. Law and intelligence have caused a constant decrease of child workers. 2700 w. Chau—Oct. 1897. No. 15606 C.

Workmen's Bill.

The "Conservative" Compensation (Workmen's) Bill of 1897. Theresa Londonderry. An examination of the opinions held by the various parties concerned, and a consideration of the effects of the bill. 1700 w. Nineteenth Cent—Sept., 1897. No. 15298 D.

MISCELLANY.

Causation.

The Philosophical Basis of Economics. Sidney Sherwood. A study in social causation aiming to show that the acts of men, social institutions, and social changes are the creation of the choices of individuals, governed by economic laws. 10000 w. An of Am Acad—Sept., 1897. No. 15050 G.

Centralization.

Administrative Centralization and Decentralization in England. J. T. Young. New conditions affecting administrative organization are considered, showing that there are three periods in the development in England. 6000 w. An of Am Acad—Sept., 1897. No. 15,049 G.

Education.

The Education of Engineers. G. F. Deacon. Address delivered by the president of the Section of Mechanics at the Toronto meeting of the British Assn. Interesting discussion of the best preparation for engineers. 4500 w. Arch, Lond—Aug. 27, 1897. No. 15200 A.

Farmers' Institutes.

Farmers' Institutes and Their Work. Frederic W. Taylor. An account of the work and the methods in different states. 2200 w. N Am Rev—Sept., 1897. No. 14990 D.

Patents.

The Extension of a Process Patent to Include the Product made Elsewhere. (Das für ein Verfahre Ertheilte Patent Erstreckt seine Wirkung auf die durch das Verfahren unmittelbar Hergestellten Erzeugnisse.) A very full discussion of the question under the German and Austrian patent law. Two articles. 9000 w. Glaser's Annalen—August 1, 15, 1897. No. 15169 G.

Prosperity.

The Return of Prosperity. Reviews the causes that have brought about what seems to promise a return of prosperity, the circumstances connected with the wheat crop in the United States being the real factor. 1500 w. Bankers' Mag, N Y—Sept., 1897. No. 15384 D.

Russian Industry.

The Industrial Awakening of the Russian Empire. F. J. Guyon. Describing Russia's material resources and the development and needs of her productive enterprises. 2700 w. Eng Mag—Oct. 1897. No. 15634 B.

Salaries.

Education and Salaries. Editorial comment on the low salaries paid to educated men in England, and the folly of under-paying. 1200 w. Prac Eng—Sept. 10, 1897. No. 15,422 A.

Technology.

The Relation between Technology and Mathematics. (Ueber die Beziehungen der Technik zur Mathematik.) An address by Prof. A. Stodola before the International Mathematical Congress of 1897, at Zurich. 3500 w. Schweizerische Bauzeitung—Sept. 4, 1897. No. 15131 B

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Assaying.

See same title under Mining and Metallurgy, Copper.

Cathode Rays.

The Action of Cathode Rays upon Salts. (Ueber die Veränderung von Salzen durch Kathodenstrahlen.) Investigations by Dr. Abegg show that some salts which are affected by light rays are unaffected by cathode rays, and *vice versa*. 1200 w. Zeitschr für Elektrochemie—Aug. 20, 1897. No. 15184 B.

Electrochemistry.

The Ion Reactions, and their Importance in Electrochemistry. (Ueber Ionenreaktionen und ihre Bedeutung für die Elektrochemie.) An address by Prof. Küster on the principles governing electrochemical reactions. 5000 w. Zeitschr für Elektrochemie—Aug. 20, 1897. No. 15182 B.

Electrolysis.

The Electrolysis of the Alkali Salts of Fatty Acids. (Der Elektrolyse Fettsaurer Alkalisalze.) Investigating the phenomena of the electrolytic action and the resulting products. 2500 w. Zeitschr für Elektrochemie—Aug. 20, 1897. No. 15185 B.

Electrosynthesis.

On Electrosynthesis. W. G. Mixter. Abstract from the *American Journal of Science*, July, 1897. A study of chemical union effected by electricity. 1000 w. Elect'n—Aug. 27, 1897. No. 15212 A.

Galvanizing.

The Electric Galvanizing of Iron. (La Galvanization Electrique de Fer.) Describing the methods of Dr. Wagner, and of Cowper Coles, both of these being in successful practical operation. 3000 w. Le Génie Civil—May 15, 1897. No. 15141 D.

Iodoform.

The Electrolytic Production of Iodoform. (Ueber die Elektrolytische Darstellung des Jodoforms.) Giving details of researches into the conditions of current and temperature for the best results. 4500 w. Zeitschr für Elektrochemie—Aug. 20, 1897. No. 15183 B.

Metallurgy.

Electricity as Applied to Metallurgy. Richard Threlfall. Review of the electro-metallurgical processes, with discussion of the various applications. 16500 w. Am Min Stand—Aug. 12, 1897. No. 15416 B.

LIGHTING.

Arc Lamps.

Arc Lamps and Their Mechanism. H. Franklin Watts. Part first criticises the arc lamps now in use, and thinks they may be improved by reducing the number of parts. 2400 w. Elec Eng—Sept. 30, 1897. Serial. 1st part. No. 15613.

On a Slow Combustion Arc Lamp Suitable for Factories and Street Lighting. W. S. Squire. Read before the Soc. of Chemical Industry. Describes the mechanical construction of the Jandus lamp, and considers also the chemical side of the question. 2000 w. Sci Am Sup—Oct. 2, 1897. No. 15641.

The Enclosed Arc Lamp. W. H. Freedman, H. S. Burroughs and J. Rapaport. Results of a large number of tests are given. Tests were made upon the relation between length and voltage of arc, the regulation, life of carbons, ratio of consumption of positive and negative carbons, and the distribution of light. Ill. 5000 w. Trans Am Inst of Elec Engs—Aug. & Sept., 1897. No. 15628 D.

Arcs.

Arc Spectra. Arthur L. Foley. Abstract of a paper read before the Am. Assn. for the Advancement of Science. A photographic study of the spectra is explained. 1200 w. Elec Eng—Sept. 16, 1897. No. 15408.

Constant Potential Arc. O. M. Rau, and F. A. Vaughn. Read before the Northwestern Electrical Association at La Crosse, Wis. The advantages and disadvantages of the several types of incandescent arc light systems and the development reached. 3000 w. W Elec—Aug. 28, 1897. No. 14975.

On the Phenomenon of the Electric Arc. André Blondel. A study of the causes of the great difference of potential between the carbons. Experiments and conclusions. 1600 w. Elect'n—Sept. 3, 1897. No. 15315 A.

On the Relations Between Arc Curves and Crater Ratios with Cored Positive Carbons. Mrs. Ayrton. Abstract of a paper read before the British Assn. at Toronto. Hypothesis, with conclusions and test of their accuracy. 1300 w. Elect'n—Aug. 27, 1897. No. 15209 A.

Edison Convention.

Edison Lighting Interests. Reviews the history of the Association of Edison Illuminating Companies. 3800 w. W Elec—Sept. 11, 1897. No. 15332.

Eighteenth Convention of the Association of Edison Illuminating Companies. Address of President Insull at Niagara Falls, on Sept. 14. 2500 w. Elec Eng—Sept. 16, 1897. No. 15410.

Electrical Equipment.

See same title under Electrical Engineering, Power.

Electrical Plant.

Electricity at St. Luke's Hospital. Illustrated description of an interesting installation. 800 w. Elec Wld—Sept. 18, 1897. No. 15442.

Electric Wagon.

Electric Light Wagon. (Elektrischer Beleuchtungswagen.) Illustrated description of a neat combination of petroleum motor and dynamo, mounted on wheels and readily moved from place to place. 1000 w. Elektrotechnische Zeitschrift—August 12, 1897. No. 15175 B.

Fixtures.

The Evolution of Electric Lighting Fixtures. Richard N. Dyer. Read before the National Assn. of Gas and Electric Fixtures, Niagara Falls, Aug., 1897. A statement of the development of the electric fixtures and the combination fixtures. 2800 w. Elec Eng—Sept. 2, 1897. No. 15065.

Interior Wiring.

The Testing of Interior Wiring. Deals with the questions raised by the new rules for testing. 2400 w. Elec Rev, Lond—Sept. 10, 1897. No. 15428 A.

Rochester, N. Y.

The Electric Lighting System of Rochester, N. Y. George B. Muldour. Illustrated description of the plants of the two companies whose united work has made this one of the best lighted cities of the United States. 2500 w. Elec Eng—Sept. 30, 1897. No. 15612.

Ship Lighting.

See same title under Marine Engineering.

POWER.

Accumulators.

On the Management of Electric Accumulators. F. G. Ansell. States briefly the changes going on in the battery, and gives directions for the management and care that will insure the greatest efficiency and length of service. 2000 w. Elec Eng, Lond—Sept. 3, 1897. No. 15313 A.

Batteries.

On Some New Forms of Gas Batteries and a New Carbon Consuming Battery. Willard E. Case. Read before the Electrical section of the British Assn. for the Advancement of Science, at Toronto, Ont. A record of experimental determinations. 1200 w. Elec Rev—Sept. 1, 1897. No. 15003.

Distribution.

Economy in Distribution of Electrical Energy. Louis A. Ferguson. Discusses methods of combination of the alternating and the direct current, the former being used for transmission and the latter for distribution. Read at Niagara Falls meeting and followed by discussion. 2700 w. Elec—Sept. 15, 1897. No. 15508.

Dynamos.

How to Build a Small Alternating-Current Dynamo without Castings. Nevil Monroe Hopkins. Describes a small machine which produces a "single phase" alternating current at 110 volts pressure, and is built without patterns and castings. Ill. 4800 w. Sci Am—Sept. 11, 1897. No. 15236.

Electrical Equipment.

The Electrical Equipment of a Southern City. W. E. Boileau. Illustrated detailed description of the combined power station of the Columbus (Ga.) Railroad Company and the Brush Electric Light and Power Company. 4000 w. Elec Wld—Sept. 4, 1897. No. 15229.

Electric Power.

The Application of Electric Power on Trunk Line Railways. George Forbes. Showing that electric traction is advisable in underground railways, desert railways, and in all cases where water power is easily available or where power may be applied to every axle. 5300 w. Eng Mag—Oct., 1897. No. 15630 B.

Electric Trap.

See same title under Mechanical Engineering, Miscellany.

Elevator Signals.

Elevator Calling Signals at the New York Telephone Building. Illustrated description of the system installed, which possesses several novel features. 1000 w. Elec Wld—Sept. 4, 1897. No. 15227.

Factory.

Electric Power in the American Ordnance Company's Works, Bridgeport, Conn. Illustrated detailed description of a factory said to be the best equipped of its kind in the country. 1100 w. Elec Eng—Sept. 30, 1897. No. 15614.

Household.

Electricity in the Household. George Heli Guy. A review of the various ways in which electricity has been adapted to the needs of domestic life, adding to the beauty, comfort and protection of the home. 3000 w. Chau—Oct., 1897. No. 15604 C.

Motors.

Alternating-Current Motors to Start Under Heavy Loads. Translation of a paper read by A. Heyland at the annual meeting of the Verband Deutscher Elektrotechniker at Eisenach. Describes the principles on which the motor is built and the action, stating the advantages. 1600 w. Elec Eng, Lond—Sept. 3, 1897. No. 15312 A.

Alternating Current Motor for Heavy Initial Load. (Wechselstrommotor mit Anlauf unter Hoher Belastung.) The Heyland motor is so wound that great initial starting power is obtained, as shown by test diagrams. 2500 w. Elektrotechnische Zeitschrift—Aug. 26, 1897. No. 15178 B.

The 200 Horse Power Walker Electric Motor (Moteur Walker de 200 Chevaux.) Describing the application of the Walker Motor to cars for regular or suburban railway traffic. 3500 w. La Revue Technique—Aug. 25, 1897. No. 15120 D.

Theory of Multiphase Motors with Variable Number of Poles. (Zur Theorie der Drehstrommotorem mit Variabler Polzahl.) A graphical and analytical discussion of the theory of the Dahlander multipolar motor. 3500 w. Elektrotechnische Zeitschrift—Sept. 2, 1897. No. 15181 B.

Motor Protection.

Is the Fuse or the Circuit Breaker Best Suited for Motor Protection? Joseph Sachs. The article shows that each method has its proper place, and if their adaptation to different classes of work is understood there will be no need of controversy. 3000 w. Elec Wld—Sept. 25, 1897. No. 15578.

Niagara Power.

Diversified Uses of Electrical Power at Niagara. Extracts from a paper of Charles F. Scott, recently read before the Engineers' Club of Philadelphia. A diagram of circuits is also given. 3000 w. W Elec—Sept. 25, 1897. No. 15621.

The Installation of the Niagara Falls Power Company. Charles F. Scott. Shows something of the means which have been taken, within the last few years, for the utilization of this power, and explains the most interesting features. Ill. 6500 w. Pro Engs Club of Phila—July-Sept., 1897. No. 15249 D.

Power Plants.

Electrotechnics. (Elektrotechnik) F. Uppenborn. A valuable paper describing and illustrating some of the more recent hydraulic electric power stations of Germany and Switzerland. 6000 w. Zeitschr d Ver Deutscher Ing—Aug. 14, 1897. No. 15100 D.

The Bakersfield Power Plant. Jas. D. Schuyler. Illustrated description of a hydro-electric power plant for lighting this city and supplying electricity for power as well as light. 2500 w. Eng News—Sept. 2, 1897. No. 15017.

The Bakersfield Transmission. Illustrated description with details. 6500 w. Jour of Elec—Aug., 1897. No. 15509.

The Central Electric Power Station at Strasburg. (La Station Centrale d'Energie Electrique de Strasbourg.) A fully illustrated description of this important plant with plan of the system of distribution, and plate showing the arrangement of machinery. 3500 w. 1 plate. Le Génie Civil—May 1, 1897. No. 15132 D.

Printing.

A Modern Electrically Driven Printing Establishment. Some of the difficulties of applying the electric motor to press machinery are noted, and an illustrated description of a recent installation in the printing-rooms of M. R. O'Loughlin & Co, New York. 1500 w. Elec Wld—Sept. 25, 1897. No. 15577.

Transformers.

Design, Construction and Test of a 1250-Watt Transformer. Henry S. Carhart. Describes the construction of a transformer by two students, under the direction of the writer, in order to determine how far theory dictated correct practice. 1700 w. Elec Wld—Sept. 18, 1897. No. 15440.

Transmission.

Electric Power Transmission. Walter Dixon. Read before the Federated Inst. of Min. Engs. A brief paper calling attention to the advantages of multiphase electrical machinery, followed by discussion. 1600 w. Col Guard—Sept. 17, 1897. No. 15563 A.

Wind Power.

Electric Plant Run by Wind. From the *Philadelphia Times*. Brief description. 800 w. Elec Rev, Lond—Sept. 3, 1897. No. 15288 A.

TELEGRAPHY AND TELEPHONY.

Africa.

The Telegraphic System of French West Africa. From *L'Illustration*. An account of the difficulties in establishing the system. 1400 w. Sci Am Sup—Sept. 18, 1897. No. 15362.

Annunciator.

Improved Station Annunciator. (Der Neue Stationsanrufer.) The Wetzer annunciator enables any telegraph or other station to be called without affecting any other station in the same circuit. 1500 w. Elektrotechnische Zeitschrift—August 26, 1897. No. 15179 B.

Armatures.

On the Construction of Armature Cores. William Baxter, Jr. Directions with illustrations. 2200 w. Am Mach—Sept. 2, 1897. No. 15046.

Early Telegraphy.

The Telegraphs of the United Kingdom. Charles Knight. Notes reviewing the history of the telegraph in the United Kingdom. 1000 w. Elec Rev, Lond—Sept. 3, 1897. Serial. 1st part. No. 15287 A.

Electrophone.

The Electrophone. J. Wright. Describes the instrument and its operation, by use of which one may sit quietly at home and yet enjoy the latest comedy, opera or tragedy. 1300 w. Elec Eng, Lond—Sept. 10, 1897. No. 15498 A.

Marconi System.

Marconi Telegraphy. Abstract of the patent specification. Ill. 3500 w. Elect'n—Sept. 17, 1897. No. 15589 A.

Telegraphy Without Wires in Germany. A summary description of experiments by Marconi and by Prof. Rubens of Frankfort. 1100 w. Cons Repts—Sept., 1897. No. 15055 D.

The Trial of the Marconi Telegraph at Spezia. Report of the trials made July 11, 12, and 13, and of other work. Ill. 1700 w. Sci Am Sup—Sept. 4, 1897. No. 15010.

Montreal.

New Building and Equipment of the Bell Telephone Company, Montreal. Illustrated detailed description. 1800 w. Can Elec News—Sept., 1897. No. 15363.

Quadruplex Telegraph.

The Roberson Quadruplex Telegraph. Brief description with illustration, of a system which has given favorable results so far as tested 600 w. Elec Eng—Sept. 30, 1897. No. 15615.

Submarine Telegraphy.

Submarine Telegraphy—A New French Transatlantic Cable. Henry Haynie. A cable being laid from Orleans, Mass., in Cape Cod, to the city of Brest, in ancient Brittany, paralleling the route of the old French cable, with information of submarine work. 2800 w. Sci Am Sup—Sept. 25, 1897. No. 15516.

Telephone Exchanges.

A Method of Working Telephone Exchanges from the Electric Light Supply. C. A Smith. Suggests an efficient and economical method of changing secondary cells. Ill. 400 w. Elec Rev, Lond—Aug. 27, 1897. No. 15202 A.

The Binghamton, N. Y., Telephone Exchange. Harry A Gardner. Illustrates and describes this plant, calling attention to the novel arrangement of many old and some new features in the equipment. 2700 w. Elec Eng—Sept. 23, 1897. No. 15517.

The Hartford, Conn., Exchange of the Southern New England Telephone Co. Illustrated detailed description 1700 w. Elec Eng—Sept. 9, 1897. No. 1525[illegible].

Without Wires.

Telegraphy Without Wires in Germany. Charles de Kay. An account of experiments made in Germany and in England. 1100 w. Elec Rev—Sept. 29, 1897. No. 15601.

MISCELLANY.

Alternator.

A Universal Alternator for Laboratory Purposes. Henry S. Carhart. Read before the Am. Assn. for the Adv. of Science. Describes the machine. 800 w. Elec Eng—Sept. 16, 1897. No. 15409.

Armatures.

Right- and Left-Handed Armature Winding. C. C. Hawkins. Explains the governing principles for determining the "hand" of an armature-winding, and gives illustrated applications to the various kinds of armatures, and directions for winding. Elect'n—Sept. 10, 1897. No. 15432 A.

Cells.

On a Simple Modification of the Board of Trade Form of the Standard Clark Cell. H. L. Callendar, and H. T. Barnes. Explains the construction of a very simple form of cell, devised by the writers, resembling the Board of Trade form, but somewhat more easily made, and also entirely free from diffusion lag in the changes of its E. M. F., consequent upon the change of temperature. 1400 w. Elect'n—Sept. 10, 1897. No 15430 A.

The Carbon Cell. Brief description of recent experiments of Dr. Borchers made to determine whether carbon monoxid could be oxidized in an electrolytic cell with the production of current, with comment. Ill. 2000 w. Elect'n—Sept. 3, 1897. No. 15314 A.

Condenser.

Electrolytic Action and Insulation Resistance of a Commercial Condenser. Dr. K. E. Guthe. Abstract of a paper read before the Am. Assn. for the Advancement of Science, at Detroit. Describes experiments made and gives results. 1600 w. Elec Eng—Sept. 16, 1897. No. 15407.

Cranes.

Electric Cranes for Continuous Currents. (Appareils de Levage Electrique à Courants Continus.) Illustrating and describing a variety of electric cranes, principally for harbor service. Two articles. 6000 w. Le Génie Civil—May 22, 29, 1897. No. 15144 G.

Electrical Development.

Electrical Development in England and France Compared with American Practice. J. McGhie. Reports very favorably regarding these countries, while admitting that electricity is not used as freely as in the United States. 2200 w. W Elec—Sept. 4, 1897. No. 15098.

Electrical Engineering.

The Precision of Electrical Engineering. Francis B. Crocker. Inaugural address of the president at meeting of the Am. Inst. of Elec. Engs. Claims exactness and certainty for the methods of this branch of engineering and examines the grounds for this claim. 8500 w. Elec—Sept. 8, 1897. No. 15265.

Electric Heating.

Heating by Electricity. (Le Chauffage par l'Electricité.) Describing the Le Roy apparatus in which blocks of silicium are raised to a red heat by the electric current for purposes of warming or cooking. 1500 w. La Revue Technique—August 10, 1897. No. 15118 D.

See same title under Street and Electric Railways.

Electric Meters.

Some Tests on the Variation of the Constants of Electricity Supply Meters, with Temperature and with Current. G. W. Donald Ricks. Presented at the Toronto meeting of the British Assn. Describes tests made to afford a means of studying variations in the accuracy of the indications under varying conditions of temperature, current and potential difference. Ill. 7000 w. Elec Wld—Aug. 28, 1897. Serial. 1st part. No. 14965.

Electric Research.

Electric Research at Low Temperature. An abstract of five papers recently communicated to the Royal Society by Profs. Dewar and Fleming, on the dielectric constants of various substances at low temperatures. Ill. 5400 w. Elect'n—Sept. 10, 1897. No. 15431 A.

Electromagnetism.

The Calculation of Electromagnetic Attraction. (Die Berechnung der Elektro-magnetischen Zugkraft.) A mathematical investigation of a practical method of calculating the pull which an electro magnet exerts upon its armature under various conditions. 1500 w. Elektrotechnische Zeitschrift—August 19, 1897. No. 15176 B.

Electro-Mechanics.

The Mechanics of the Principal Electrical Phenomena. (Die Mechanik der Wichtigsten Elektrischen Erscheinungen.) Explaining the fundamental conceptions in electrical action by the corresponding mechanical ideas. Two articles. 6000 w. Elektrotechnische Zeitschrift—August 26, September 2, 1897. No. 15180 E.

Electrometer.

A Highly Sensitive Quadrant Electrometer. (Ueber ein Hochempfindliches Quadrantenelektrometer.) An illustrated description of the new electrometer of Profs. Nernst and Dolezalek, with instructions as to its calibration and use. 6000 w. Elektrotechnische Zeitschrift—August 19, 1897. No. 15177 B.

Exhibition.

The Victorian Era Exhibition. Gives illustrated description of some of the electrical exhibits. 1300 w. Elec Rev, Lond—Sept. 10, 1897. No. 15429 A.

Heat Waves.

Certain Optical and Electro Magnetic Properties of Heat-Waves of Great Wave-Length. H. Rubens and E. F. Nichols. Describes apparatus used, gives results obtained, and describes experiments. 3600 w. Phys Rev—Aug., 1897. Serial. 1st part. No. 15470 D.

Hysteresis.

A New Method of Investigating the Variations of the Magnetic Qualities of Iron with Temperature. F. H. Pitcher. Abstract of paper read at the Toronto meeting of the British Assn. Describes the method and apparatus used. 2000 w. Elec Wld—Aug. 28, 1897. No. 14966.

A Method of Determining Magnetic Hysteresis Loss in Straight Iron Strips. J. A. Fleming. Read before the Physical Society. A description of a process based upon the use of the bifilar reflecting wattmeter and which operates upon samples of iron, large or small, in the form of straight strips which are simply slipped into a long magnetized coil. 1200 w. Elec Eng, Lond—Sept. 17, 1897. Serial. 1st part. No. 15592 A.

On a New Method of Measuring Hysteresis in Iron. J. L. W. Gill. Describes instrument based upon the principle that the hysteresis loss is, by the law of the conservation of energy, numerically equal to the resultant mechanical work expended. 1000 w. Elec Wld—Sept. 4, 1897. No. 15228.

Indicator.

Rotary Electric Indicator. (Drehfeld Fernzeiger.) Describing an electric dial indicator for use on vessels between bridge and engine room. 4000 w. Elektrotechnische Zeitschrift—August 12, 1897. No. 15174 B.

Instruction.

Instruction in Practical Electricity in Night Schools. C. Walton Swoope. Illustrated account of a school adapted to the needs of those intending to become practical workers in electricity. 1000 w. Elec Wld—Sept. 25, 1897. No. 15576.

Insulation.

Liquid Air as an Insulator. Letters from J. A. Fleming and Elihu Thomson discussing the possibilities of usefulness of this agent. 1600 w. Elec Wld—Sept. 18, 1897. No. 15441.

Kite Experiment.

Franklin's Kite Experiment with Modern Apparatus. Alexander McAdie. Gives the kite experiment as described by Franklin in 1752, and describes later experiments with modern kites. Ill. 1800 w. Ap Pop Sci M—Oct., 1897. No. 15644 D.

Lightning.

Protection Against Lightning. Philip Atkinson. Comments on the ignorance and prejudice against lightning rods, and shows how these conductors should be constructed to insure protection. 900 w. Elec Eng—Sept. 2, 1897. No. 15064.

Magnetic Materials.

Magnetic Materials for Dynamos. Curves illustrating the present position of the chief magnetic materials in the three great classes of forgings, steel castings and armature stampings, with explanations. 1200 w. Elect'n—Sept. 17, 1897. No. 15587 A.

Magnets.

The Specific Magnetic Limits of Permanent Steel Magnets. (Ueber den Specifischen Grenzmagnetismus Permanenter Stahlmagnete.) An account of experimental investigations as to the influence of temperature and vibration upon the magnetic limits of steel. Two articles. 9000 w. Elektrotechnische Zeitschrift—August 12, 19, 1897. No. 15173 E.

Resistance Coils.

Some Data on the Heating Error in Resistance Coils. Frank A. Laws. Describes experiments performed under the direction of the writer to supply important data on this subject. The results are given in the form of plots. 1100 w. Tech Quar—Sept., 1897. No. 15536 F.

Roentgen Rays.

A Summary of Roentgen Ray Theories. A Vosmaer and F. L. Ortt. Considers Röntgen rays to be nothing but discharged cathode rays, and tests the hypothesis by seeing how it will explain some of the most striking experiments and facts. 1400 w. Elec Eng—Sept. 9, 1897. Serial. 1st part. No. 15261.

An Interesting Review of X-Ray Practice. Elliott Woods. Gold-foil screen described. Many important experiments and suggestions. 2200 w. Elec Rev—Sept. 15, 1897. No. 15352.

Solarization Effects in Röntgen Ray Photographs. Wm. Lispenard Robb. Experiments made are described, which seem to prove the possibility of photographic plates becoming solarized by Röntgen rays, and showing the necessity of carefully timing exposures. Ill. 1600 w. Am Jour of Sci—Sept., 1897. No. 15053 D.

The Absorption of X-Rays. (L'Absorption des Rayons X.) Experimental investigations as to the variation of opacity of various thicknesses of different materials. 1200 w. Comptes Rendus—August 23, 1897. No. 15186 D.

Rotary Converter.

Armature Reactions in a Rotary Converter. Robert B. Owens, D. W. Hawksworth and H. W. Doubrava. Experimental study of a machine of the well-known consequent pole type, with the results. Ill. 1800 w. Trans Am Inst of Elec Engs—Aug. & Sept., 1897. No. 15629 D.

Transformers.

Iron Losses in Transformers and the Higher Harmonics in the Potential-Difference Wave. William Beckit Burnie. Criticism of statements made by C. P. Feldmann in article entitled "The Influence of the Shape of the E. M. F. Curve upon the Iron Losses of Alternating Current Transformers." 1200 w. Elect'n—Aug. 27, 1897. No. 15210 A.

Wrought Iron.

The Magnetic Properties of Annealed Wrought Iron Manufactured from the Iron Sand of New Zealand. Ernest Wilson. Describes the product, difficulties in reducing, and method of experiment, giving results. 800 w. Elect'n—Sept. 17, 1897. No. 15588 A.

MARINE ENGINEERING.

BOILERS AND ENGINES.

Cambria.

New Vessel for the Holyhead and Dublin Service. Describes a fine vessel built for use of the London and Northwestern Railway Co., recently launched from the Leven Shipyard. 1400 w. Steamship—Sept., 1897. No. 15235 A.

Danish Boats.

Danish Steam Railway Ferries and Ice-Breaking Steamers. I. C. Tuxen. Illustrated description of boats constructed to continue the traffic during the entire year, between the islands and through the drifting ice. 2000 w. Marine Engng—Sept., 1897. No. 15257 C.

Indicator.

See same title under Electrical Engineering.

Japan.

Shipping Affairs in Japan. Editorial consideration of some of the most important points in the rapid development of the mercantile marine of this country. 2500 w. Engng—Sept. 17, 1897. No. 15555 A.

Paddle Steamer.

Paddle Steamer I. Ferencz Josef. Brief description, dimensions and illustrations of Danube steamer. 900 w. Engr, Lond—Aug. 27, 1897. No. 15088 A.

Shipbuilding.

Shipbuilding and Marine Engineering on the Thames in the Victorian Era. Part first, as an introduction to the subject to be considered, reviews events preceding the present reign, the invasion of the Dutch, as recorded by Samuel Pepys, the threatened invasion of the Spaniards, &c. Ill. 3800 w. Engr, Lond—Sept. 3, 1897. Serial. 1st part. No. 15344 A.

Shipbuilding in Theory and Practice. The first of a series of articles in which it is the writer's intention to give a clear and explicit description of the calculations employed and the methods adopted in the science of shipbuilding. 900 w. Mech Wld—Sept. 3, 1897. Serial. 1st part. No. 15294 A.

Ship Lighting.

The Lighting Plant on the "Rotterdam." Illustrated description of interesting equipment, possessing some features unknown to American practice. 1000 w. Elec Wld—Sept. 11, 1897. No. 15290.

Stability.

Comparison between the Alabama and the Prince George. (Comparison entre le Cuirassé Américain Alabama et le Cuirassé Anglais Prince George.) Reviewing a discussion in the London Engineer concerning the alleged inferior stability of the American vessel. 1600 w. Le Génie Civil—July 10, 1897. No. 15163 D.

Steel Construction.

Steel Considered as a Material for Ship Construction and Machinery. C. A. McAllister. The importance of selecting and testing material. The unfitness of steel made by the Bessemer process for marine construction. The writer's preference for acid open-hearth steel, and general discussion of requirements, &c. 1600 w. Marine Engng—Sept., 1897. No. 15258 C.

Torpedo-Boats.

Our Latest Thirty-Knot Torpedo-Boats. R. G. Skerrett. Describes these boats which are really torpedo boat destroyers. 1500 w. Harper's Wk—Sept. 11, 1897. No. 15028.

Turret-Ships.

Ericsson's First Monitor and the Later Turret Ships. George L. Fowler. The evolution of a radical change in battle-ship design. Ill. 3300 w. Eng Mag—Oct., 1897. No. 15639 B.

Vibrations.

Method of Securing an Autographic Record of Steamship Vibrations. W. F. Durand. Describes instrument for automatically recording vibrations and explaines its principles. Ill. 1600 w. Marine Engng—Sept., 1897. No. 15256 C.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Boiler Construction.

Materials and Tests for Boiler Construction in America. Condensed report of the committee of the American Boiler Manufacturers' Assn., presented at Philadelphia. 3000 w. Ir & St Trds Jour. Aug. 28, 1897. No. 15234 A.

Boiler Test.

Test of a Cahall Boiler. Report of George H. Barrus of a test of one of the 200-H. P. Cahall water-tube boilers at the Narragansett Mills, Fall River, Mass. Extract showing exceptionally good results. 800 w. R R Gaz—Sept. 24, 1897. No. 15530.

Condensers.

Condensers. E. J. Philip. Read before the Canadian Assn. of Stationary Engs. Explains the advantages of their use and describes several types. Also briefly discusses air pumps. 2000 w. Can Eng—Sept., 1897. No. 15325.

Efficiency.

Causes of the Variable Efficiency of Steam Boilers and Their Influence on Tests. F. G. Gasche. An account of experimental work with drawings and discussion. 6700 w. Jour of W Soc of Engs—Aug., 1897. No. 15610 D.

Failure.

Failure of an Upright Boiler. From *The Locomotive.* Describes the conditions and the cause of failure. 800 w. Engr—Sept. 4, 1897. No. 15099.

Furnace.

A Combination Retort and Reverberatory Furnace. Courtenay De Kalb. Brief illustrated description of a type of furnace possessing peculiarities intended to meet the necessities of laboratory instruction. 350 w. Trans Am Inst of Min Engs—Sept., 1897. No. 15397 D.

Grease Extraction.

The Removal of Grease from Condensed Steam. (Entfettung des Kondensirten Abdampfes.) Describing Dehne's apparatus for filtering the grease from surface condenser water before it is returned to the boiler. 1200 w. Zeitschr d Ver Deutscher Ing—Aug. 2, 1897. No. 15104 D.

Indicators.

The Indicator. G. B. Risler. On the value of the indicator with directions for its proper use. 1500 w. Can Eng—Sept., 1897. No. 15326.

Powdered Coal.

Burning Powdered Coal Under Steam Boilers. Account of a series of experiments, recently conducted in New York, on a new method invented by Carl Wagener, a German engineer. The apparatus is described and illustrated, and the results of the tests discussed editorially. 1600 w. Eng News—Sept. 16, 1897. No. 15378.

Purifier.

Improved Feed Water Purifier. (Neue Wasserreiniger für Kesselspeise.) Showing several forms of apparatus for purifying feed water by heating, precipitating, and filtering. 4000 w. Zeitschr d Ver Deutscher Ing—Aug. 14, 1897. No. 15103 D.

Staybolts.

The Breaking of Staybolts. A summary of the troubles, their causes and possible remedies, with suggestions that have been made. 3300 w. Am Eng & R R Jour—Sept., 1897. No. 14986 C.

Repairs.

How to Make Light Repairs on the Locomotive Boiler. Henry J. Raps. Suggestions for repairs and care. Ill. 2300 w. Loc Engng—Sept., 1897. No. 15201 C.

Safety Valve.

The Lever Safety Valve. C. A. Collett. The object of the article is to ascertain, as far as possible, to what extent the rules laid down by authors harmonize, and to enable the engineer to decide whether his safety valve is of ample capacity to relieve the boiler of an over-production of steam. 1700 w. Mech Wld—Sept. 17, 1897. No. 15541 A.

Settling Tank.

A Feed-Water Settling Tank. Walter Ferris. Describes the latest arrangement of a large iron works, for the prevention of scale and sediment in boilers. Ill. 1000 w. Am Mach—Sept. 9, 1897. No. 15262.

Superheating.

Superheated Steam. An account of the experiments carried out on a Sulzer compound-condensing steam engine in Bavaria. 1100 w. Bos Jour of Com—Sept. 11, 1897. No. 15311.

Traps.

About Steam Traps. W. H. Paine. Notes from a paper recently read before the Rhode Island. No. 2, National Assn. of Stationary Engineers of Pawtucket. Describes the trap under discussion and considers piping and connections, repairs, &c. 2000 w. Bos Jour of Com—Sept. 25, 1897. No. 15525.

Waste Heat.

Waste Heat and Gases from Coke Ovens. Charles E. Bowron. Describes how they are successfully utilized in the generation of steam by the Tennessee Coal, Iron and Railroad Company. Ill. 800 w. Col Eng—Sept., 1897. No. 15350 C.

COMPRESSED AIR.

Address.

Compressed Air: Its Production, Transmission and Use. William Prellwitz. Address delivered at Lafayette College, Easton, Pa. Discussion of the subjects named. 5500 w. Compressed Air—Sept., 1897. No. 15510.

Air-Compressor.

Corliss-Valved Air-Compressor. Herr Kaufhold. From a communication to *Glückauf*. Describes the air-compressor designed by Ferdinand Struad. There is only one air cylinder, the piston of which is driven directly off the crank-shaft. Ill. 2000 w. Col Guard—Sept. 3, 1897. No. 15336 A.

Traction.

Compressed Air Traction. A résumé of the present state of the equipment on 125th St., New York, taken from a recent publication by the American Air Power Company, with editorial. 900 w. Am Eng & R R Jour—Sept., 1897. No. 14982 C.

ENGINES AND MOTORS.

Balancing.

The Action of Masses in Crank Transmission, and their Equalization in Multiple Crank Engines. (Die Massenwirkungen am Kurbelgetriebe und ihre Ausgleichung bei Mehrkurbligen Maschinen.) A very full and valuable contribution to the study of balancing the reciprocating parts of steam engines, by Prof. Dr. Lorenz. Two articles. 9000 w. Zeitschr d Ver Deutscher Ing—August 28, September 4, 1897. No. 15109 G.

Crank Action.

The Motion of Winding Engines for Various Crank Positions. (Das Anlaufen der Fördermaschinen aus jeder Kurbelstellung.) A graphical investigation of the crank action on double cylinder engines, showing the causes for irregularity of motion. 1200 w. Zeitschr d Ver Deutscher Ing—August 21, 1897. No. 15107 D.

Fly-Wheels.

About Fly-Wheels. Their strength and how figured. 2200 w. Bos Jour of Com—Sept. 4, 1897. No. 15006.

Gas Engines.

The Cycles of Gas and Oil Engines. James D. Roots. This first of a series of articles contains a table of classification, into ten types, explanation of reasons for so classifying. 3000 w. Engr, Lond—Sept. 3, 1897. Serial. 1st part. No. 15342 A.

The Donaldson Compound Gas Engine. Illustrated description. 500 w. Elec Rev, Lond—Sept. 3, 1897. No. 15286 A.

The Gas and Petroleum Motors at the Geneva Exposition, 1896. (Die Gas und Petroleummotoren auf der Schweizerischen Landesausstellung in Genf, 1896.) Three articles containing many illustrations of the latest Continental practice and construction. 6000 w. Schweizerische Bauzeitung—August 14, 21, 28, 1897. No. 15129 G.

Heat.

A Theoretical and Practical Study of the Utilization of Heat. (Etude Theorique et Pratique de l'Utilization de la Chaleur.) A valuable series of papers by MM. Damour and Waton treating of the calorific value of combustibles and the best methods of utilizing it. Serial. Part 1, and 2. 10000 w. Le Génie Civil—May 29, & June 19, 1897. No. 15145 G.

High Speed.

High Speed Engines for Industrial Purposes. (Les Machines a Grand Vitesse dans l'Industrie.)

Describing the successful and economical performance of the Willans high speed engine in French spinning mills. 1200 w. La Revue Technique—August 10, 1897. No. 15114 D.

Knocking.

Knocking in Engines The causes of knocks in steam spaces and the difficulty of locating them. 1400 w. Prac Eng—Aug. 20, 1897. No. 14972 A.

Motors.

See same title under Electrical Engineering, Power.

Oil Engine.

Southall's Ideal Oil Engine. Illustrated description of an engine working on the Otto cycle, and using only heavy petroleum for both starting and running. 700 w. Engr, Lond—Sept. 17, 1897. No. 15549 A.

The "Ruston" Oil Engine. Brief illustrated description. 900 w. Engng—Aug. 27, 1897. No. 15078 A.

Piston Packing.

Piston Packing Rings of Modern Steam Engines. Otto C. Reymann. Investigates how packing rings for steam engines should be designed in order to exert a certain amount of pressure upon the cylinder walls. 1700 w. Prac Eng—Aug. 20, 1897. Serial. 1st part. No. 14973 A.

POWER AND TRANSMISSION.

Elevator Accident.

Elevator Accident in the American Tract Society Building. Explains the system of elevators installed, giving description, with particulars of the accident. 2000 w. Eng Rec—Sept. 18, 1897. No. 15466.

Fall of an Elevator at the Tract Society Building, New York. Describes the type of elevator, and the accident, with illustration. 1500 w. Sci Am—Sept. 25, 1897. No. 15514.

Fall of a Passenger Elevator in New York City. Brief account of the accident at the American Tract Society Building, on Sept. 10, 1897, which caused the death of two persons. 900 w. Eng News—Sept. 16, 1897. No. 15376.

The Elevator Accident at the Tract Society Building, New York. Report of the opinion of the coroner's jury, with comments. 1200 w. Sci Am—Oct. 2, 1897. No. 15619.

The Fall of an Elevator in the Building of the American Tract Society. Illustrations showing the construction of the elevator machinery and safety appliances, with explanation, and suggestion of possible causes of the accident. 3500 w. Eng News—Sept. 23, 1897. No. 15535.

Gearing.

Researches in Worm Gearing. (Versuche mit Schneckengetrieben.) A very thorough investigation by Prof. Stribeck, showing the form and pitch adapted to give the best efficiency, with investigations as to lubrication; many diagrams. 7500 w. Two articles. Zeitschr d Ver Deutscher Ing—Aug. 14, 21, 1897. No. 15101 G.

Hydraulic Power.

Motive Power in the Maritime Alps. (Les Forces Motrices des Alpes-Maritimes.) An account of the plans to utilize the hydraulic power of the rivers Var and Cians, in the south of France. 1500 w. La Revue Technique—Aug. 25, 1897. No. 15125 D.

Power Distribution.

The Direct Distribution of Energy. Charles E. Emery. Dealing especially with plants for the distribution of steam. 4100 w. Eng Mag—Oct., 1897. No. 15637 B.

Rheinfelden.

The Utilization of the Power of the Rhine at Rheinfelden. (Utilization des Forces Motrices du Rhin à Rheinfelden.) A description of the important hydraulic and electric plant under construction on the Rhine above Basle, with photograph and drawings of the turbines and generators. Two articles. 7000 w. Le Génie Civil—July 3, 17, 1897. No. 15158 G.

Steam Economy.

Economy in the Generation and Use of Steam. W. H. Wakeman. Calls attention to some things that might be done better than they usually are, and suggests some changes. 1400 w. Mach, N Y—Sept., 1897. No. 15097.

Turbines.

A Notable Pair of Horizontal Turbines. Gives illustrated description of a powerful pair of turbines erected for the Boston and Montana Consolidated Copper and Silver Mining Company, at Great Falls, Montana. 900 w. Sci Am—Sept. 25, 1897. No. 15513.

The Turbines of Ganz & Co., at the Budapest Exposition. (Die Turbinen von Ganz & Co. auf der Millenniums-Landesausstellung zu Budapest.) With excellent illustrations of vertical and horizontal turbines and governors by this well-known firm. 5000 w. Zeitschr d Ver Deutscher Ing—Aug. 21, 1897. No. 15105 D.

Water-Wheels.

Limiting Factors in the Government or Regulation of Water Wheels. Abridged paper by Mark A. Replogle. Indicates the lines on which a water-power plant must be laid down to attain best results. 1200 w. Col Eng—Sept., 1897. No. 15349 C.

SHOP AND FOUNDRY.

American Shop.

A Modern American Shop. Description of some of the machines and operations seen during a recent visit to the works of the Mossberg & Granville Manufacturing Company. Ill. 1800 w. Mach, N. Y—Sept., 1897. No. 15095.

Bearings.

Roller Bearings. Detailed description of the exhibit of the Roller Bearings Company, of Delahay Street, Westminster, showing recent improvements, and claiming to have proved that rolling motions for bearings are now being successfully applied to the heaviest loads with satisfactory results. Ill. 1400 w. Engr, Lond—Sept. 3, 1897. No. 15345 A.

Roller Bearings. W. Bayley Marshall. Abstract of a paper read before the Toronto meeting of the British Assn. for the Advancement of Science. Presents the advantages from the use of roller bearings, the requirements of such bearings, and some of the results obtained. 1300 w. Can Eng—Sept., 1897. No. 15327.

Brass.

The Value and Use of Aluminum, Manganese and Silicon in the Brass Foundry. F. J. Davis. From Proceedings of the American Foundrymen's Assn. Directions for the use of these metals in order to secure good results. 1300 w. Am Mach—Sept. 9, 1897. No. 15264.

Castings.

Skimming Castings. R. D. Moore. Explains the principle of skimming metal effectually, or of constructing a skim gate that will separate the dross from the pure metal. Ill. 900 w. Am Mach—Sept. 16, 1897. No. 15373.

Cost Keeping.

Cost-Keeping Methods in Machine-Shop and Foundry. Henry Roland. Dealing with the elements of cost and the influence of wage systems. 3700 w. Eng Mag—Oct., 1897. No. 15633 B.

Cranes.

See same title under Electrical Engineering, Miscellany.

Dies.

Dies for Punching Blanks for Grooved Armature Cores. William Baxter, Jr. Gives illustrated description of the forms designed by the writer for this use, with the objects sought to be accomplished. 1500 w. Am Mach—Sept. 23, 1897. No. 15524.

Facings.

The Mission of Foundry Facings. Henry Hansen. Discussion of statements made in paper by H. F. Frohman, presented before the Western Foundrymen's Assn. 1200 w. Am Mach—Sept. 2, 1897. No. 15047.

Fire Department.

A Shop Fire Department. Describes the organization of the men and their assignment to duties in case of fire in the shop of J. H. Williams & Co., of Brooklyn, N. Y., manufacturers of drop forgings. 1200 w. Am Mach—Sept. 23, 1897. No. 15523.

Flanges.

The Calculation of the Strength of Loose and Fast Flanges. (Berechnung der Festigkeit Loser und Fester Flansche.) An analytical discussion of the strength of pipe flanges, when cast in one piece with the body, and when considered separately. 6000 w. Zeitschr d Ver Deutscher Ing—Sept. 4, 1897. No. 15113 D.

Friction Wheels.

Paper Friction Wheels. M. W. Danielson. Gives results of testing eight kinds of paper friction wheels and suggests one more way of making them. 1000 w. Am Mach—Sept. 2, 1897. No. 15048.

German Shops.

German Workshops. Impressions of the writer with comments. 1600 w. Mach, N Y—Sept., 1897. No. 15096.

Isca Foundry.

The Isca Foundry at Newport, South Wales. Brief illustrated description. 900 w. Ir & Coal Trds Rev—Sept. 10, 1897. No. 15492 A.

Jigs.

The Construction of Jigs for Drilling Holes in the End Rings of Armature Cores. William Baxter, Jr. Shows the necessity for obtaining accurate spacing of the holes, and in order to secure it the need of having a jig perfectly true, and explains how to secure this accuracy. Ill. 2000 w. Am Mach—Sept. 16, 1897. No. 15372.

Molding.

The Tabor Molding Machine. Illustrated description of an improved machine, operated by compressed air. 1200 w. Am Mach—Sept. 30, 1897. No. 15622.

Rear-Fork End.

A Rear-Fork End—How to Make It. W. A. Warman. Illustrated detailed description. 600 w. Am Mach—Sept. 2, 1897. No. 15045.

Rim-Drilling.

Automatic Rim-Drilling Machine. Describes a machine designed for making wooden rims for bicycle wheels at a very rapid rate. Ill. 700 w. Am Mach—Sept. 30, 1897. No. 15623.

Shop Notes.

Some Notes from an English Shop. James Vose. Illustrated description of the works of Meldrum Bros., Manchester, Eng., with the methods and tools in use. 3000 w. Mach, N Y—Sept., 1897. No. 15093.

Taper Turning.

Taper Turning Attachments. Illustrated description of an attachment for this work. 1000 w. Ir Age—Sept. 2, 1897. No. 15060.

Tools.

The Care of Hand Saws. Julien A. Hall. Hints for keeping a saw in order. 1600 w. Ry Mas Mech—Sept., 1897. No. 15039.

The Valuation of Machine Tools. Editorial on the methods of estimating the value of machine shop equipment. 1000 w. Am Mach—Sept. 30, 1897. No. 15625.

Specification of Error Limits for Machine Tool Construction. A. A. Fuller. Discusses the importance of specifying the quality of workmanship. 1800 w. Am Mach—Sept. 16, 1897. No. 15374.

Staking Tools. A. H. Cleaves. Illustrated description of a jeweler's staking tool, with by a set of tools for various requirements. 1000 w. Am Mach—Sept. 16, 1897. No. 15370.

MISCELLANY.

Automata.

Some Remarkable Automata. W. F. Durfee. Remarks with description of three ingenious exhibits, as given in the Descriptive Inventory of James Cox, of London. 1100 w. Am Mach—Sept. 9, 1897. No. 15263.

Automobiles.

A Study of Automobile Vehicles. (Etudes sur les Automobile Vehicles.) P. Crépy. Begins with a review of the various types, discussing recent performances. Serial. Part 1. 2000 w. La Revue Technique—August 25, 1897. No. 15121 D.

Electric Cabs. Description of the cabs in use in London, dealing chiefly with the internal arrangements. 2000 w. Arch, Lond—Sept. 3, 1897. No. 15309 A.

Motor Road Vehicles. Joseph Sachs. Brief review of efforts to solve this problem, and a presentation of general features needing consideration. Ill. 5000 w. Jour Fr Inst—Sept., 1897. Serial. 1st part. No. 15052 D.

The Riker Electric Trap. Illustrated description. 2000 w. Elec Wld—Sept. 4, 1897. No. 15230.

Balloon Expedition.

The Andrée Expedition. (L'Expedition Andrée.) Description, with photographs of the construction of the buildings and apparatus for inflation of the balloon of the Andrée expedition at Spitzbergen. 4500 w. Le Génie Civil—July 17, 1897. No. 15167 D.

Bicycles.

The Tuttle Chainless Bicycle. Illustrated description of a bicycle embodying unique and ingenious features. 1000 w. Ir Age—Sept. 2, 1897. No. 15059.

Cannon.

Improved Dismounting Cannon. (Nouveaux Canons Démontables.) Col. Fix. Describes the improved system of Col. Lycoudis of dismounting field pieces for use in mountainous countries. Two mules only are required instead of three as formerly. Two articles. 3500 w. La Revue Technique—August 10 and 25, 1897. No. 15119 E.

Coal Bins.

The Computation of Strains in Coal and Grain Bins. A discussion of bin pressures, computation of strains, &c. 1500 w. Eng News—Sept. 23, 1897. No. 15534.

The Design of the Coal Bin at the Paterson Electric Light Station. Letter from Messrs. Milliken Bros., the designers and builders of the coal bin that failed recently at Paterson, N. J., with editorial comment. 2000 w. Eng News—Sept. 23, 1897. No. 15531.

Cold.

Apparatus for the Production of Low Temperatures. (Machine pour l'obtention des Basses Temperatures.) An illustrated description of the Linde apparatus by which atmospheric air is frozen. Two articles. 5000 w. Le Génie Civil—May 15, 22, 1897. No. 15139 G.

Lubrication.

A Determination of the Specific Resistance and Temperature Coefficient of Oil in Thin Films, and the Application of These Results to the Measurement of the Thickness of the Oil Film in Journal Boxes. F. L. O. Wadsworth. Gives results of investigations. 4500 w. Phys Rev—Aug., 1897. No. 15469 D.

Levitation.

The Experiments of Prof. Wellner. (Experiences du Professeur Wellner.) Describing the experiments made to ascertain the levitating power of aerial screw propellers. Two sizes of propellers were driven by a stationary engine, and the lifting power measured at various speeds. 800 w. Le Génie Moderne—September 15, 1897. No. 15197 B.

Memoir.

Otto H. Mueller; His Life and Influence on Machine Construction. (Otto H. Mueller: sein Leben und seine Bedeutung für den Maschinenbau.) A very interesting account of one of the pioneers of German engineering, with early sketches of machine details, &c. 4000 w. Zeitschr d Ver Deutscher Ing—Aug. 28, 1897. No. 15108 D.

Packing.

Packing as a Product of the Rubber Factory. Gives history of the use of packing with illustrated description of types. 3300 w. Ind Rub Wld—Sept. 10, 1897. No. 15388 D.

Plumbago.

Plumbago. Editorial on the use of plumbago as a lubricator, the best form in which to apply it, scarcity of this form, &c. 1000 w. Engng—Sept. 10, 1897. No. 15462 A.

Press.

Presses for Baling Hay and Straw. (Presses pour le Foulage du Foin et de la Paille.) Illustrating and describing improved portable screw presses for agricultural purposes. 1000 w. 1 plate. Le Génie Civil—July 17, 1897. No. 15166 D.

Pump.

An Improved Pump with Constant Discharge. (Nouvelle Pompe á Débit Constant.) The Holst pump is made with a peculiar lever motion by which the plunger moves at a uniform velocity throughout the entire stroke, and two such pumps give a practically constant discharge. 2500 w. Le Génie Civil—June 12, 1897. No. 15152 D.

Scales.

Influence of the Position of Rods and Beams upon the Accuracy of Decimal Scales. (Nachweisung des Einflusses des Anzugs der Zugstangen und des Ansteigens des Unterbalkens auf die Empfindlichkeit der Decimalwaagen.) A highly mathematical treatment of the sources of error in so-called decimal weighing machines. 3500 w. Glaser's Annalen—Aug. 15, 1897. No. 15171 D.

Steam Crane.

How to Run a Steam Crane. Joseph Horner. General instructions. 1800 w. Mech Wld—Sept. 10, 1897. No. 15488 A.

Tires.

An Investigation of the Physical Properties of Compressed Iron Tires. Frederick Grover. Report of a series of tests by the writer, which led him to believe, by the results obtained, that Bauschinger's law concerning the range of elastic limit fails under extreme treatment of the specimen. Ill. 1800 w. Engr, Lond—Sept. 3, 1897. No. 15341 A.

Viscometer.

Redwood's Viscometer in Practice. H. Andrews and G. E. Brown. Practical directions for the manipulation of this instrument which will enable any one to carry out with accuracy and speed the testing of any oils from a viscosimetric point of view. 3500 w. Prac Eng—Sept. 17, 1897. No. 15593 A.

MINING AND METALLURGY.

COAL AND COKE.

Accident.

Report on the Devon Colliery Accident. Official report concerning this accident which occurred March 26, 1897. 3000 w. Col Guard—Aug. 27, 1897. No. 15084 A.

Berlin.

The Fuel Consumption of the City of Berlin in 1896. (Der Brennmaterialverbrauch in Berlin im Jahre 1896.) An interesting report on the relative proportion of various kinds of coal used, with plate showing the results graphically from 1890 to 1896. 1500 w. 1 plate. Glückauf—Aug. 28, 1897. No. 15189 B.

British Coal.

The British Coal Industry—Its Troubles and Their Remedies. Considers the movement to regulate production and prices, not only in England, but in all coal-producing countries. 3700 w. Ir & Coal Trds Rev—Sept. 10, 1897. No. 15493 A.

Bruay.

The New Works of the Mines of Bruay. (La Fosse No. 5, des Mines de Bruay.) Describes the plant installed in the new pit of the Bruay coal mines in the Pas-de-Calais district, with plate of pumping engines. 2500 w. 1 plate. La Revue Technique—Aug. 25, 1897. No. 15122 D.

Coal Cargoes.

The Dangers of Coal Cargoes. Extracts from the report of the commissioners appointed by the New South Wales Government to enquire into the cause of the dangers to which vessels carrying coal are said to be peculiarly liable, and as to the best means for removing or lessening the same. 3500 w. Col Guard—Sept. 10, 1897. No. 15455 A.

Coal-Felds.

Colonial Coalfields. Part first is confined to the fields of British Columbia, giving production, value, importance of export trade, &c. 3500 w. Ir & Coal Trds Rev—Aug. 27, 1897. Serial. 1st part. No. 15205 A.

New Coalfields. Notes on the importance of the fields in Zululand and in the United States of Colombia. 1100 w. Bd of Trd Jour—Sept., 1897. No. 15543 A.

The Geology of the Donetz Coalfield. M. Tschernyschew and L. Loutouguin. Abstract of an article describing this most important coal-producing district of Russia. 1500 w. Col Guard—Sept. 3, 1897. No. 15334 A.

Coal Formation.

The Formation of Coal and Generation of Fire Damp. M. F. Rigaud. From a communication to the *Revue Scientifique*, Paris. Part first considers the age and origin of coal deposits, ferrous central nucleus, and the carbon contribution of vegetable origin. 2500 w. Col Guard—Sept. 10, 1897. Serial. 1st part. No. 15452 A.

Coke Oven.

The Simon-Carves Coke Oven. Interesting particulars in regard to this coke-oven system for the manufacture of coke and recovery of by-products. The coal is converted into coke by heat transmitted through the oven walls. 1800 w. Col Guard—Sept. 17, 1897. No. 15559 A.

Dusty Mines.

An Unrecognized Danger in Dusty Coal Mines. James Ashworth. Showing that bonneted and other safety lamps are not a safe means of lighting coal mines where coal dust as well as fire damp is present, and the way in which such risks may be practically obviated. Ill. 7000 w. Col Guard—Sept. 3, 1897. No. 15333 A.

Early Conditions.

Slavery in the Coal Mines of Scotland. James Barrowman. Read at the Federated Inst. of Min. Engs. Early history of the industry, its connection with salt making, the conditions of labor, and the causes that led to the binding of workmen to their masters. 1800 w. Col Guard—Sept. 17, 1897. No. 15562 A.

Fifeshire.

The Methods of Working Minerals, Secondary Haulage, and Ventilation in Fifeshire. Andrew Burt. Abstract of a paper read before the Federated Inst. of Min. Engs. Early history of the mines, the present system of longwall working, the stoop and room working, &c. 5000 w. Ind & Ir—Aug. 27, 1897. No. 15089 A.

Regulation.

The Regulation of Coal Output and Prices. Part first considers the cases of the Westphalian coal trade syndicate, the New South Wales, the scheme of Sir George Elliot, of D. A. Thomas, and Sir W. T. Lewis, with further proposals. 7500 w. Ir & Coal Trds Rev—Sept. 17, 1897. Serial. 1st part. No. 15583 A.

Sale of Collieries.

The Law as to Principal and Agent for the Sale of Collieries and Coal. Brief review of cases in England. 3000 w. Col Guard—Sept. 10, 1897. No. 15453 A.

Separators.

The Development of Separating Apparatus. (Ueber die Entwickelung der Separations Apparate.) Describing and illustrating the improvements in apparatus for separating and screening coal. 2500 w. Glückauf—August 28, 1897. No. 15188 B.

Submarine Mining.

Submarine Coal Mining at Bridgeness, N. B. Henry M. Cadell. Read before the Federated Inst. of Min. Engs. Describes the formation, the difficulties met and conquered, &c. 2000 w. Col Guard—Sept. 17, 1897. No. 15560 A.

Tubbing.

Substitution of Cast Iron Tubbing for Wood in a Belgium Pit. L. Verniory. From a communication to the Assn. des Ingenieurs Sortis de l'Ecole de Liége. Describes the modern tubbing constructed in 1848, the trouble with leakage and the replacing by iron tubbing, the water being kept back during the operation by means of a concreted plate-curve constructed under the water level. 3500 w. Col Guard—Sept. 3, 1897. Serial. 1st part. No. 15335 A.

Wallsend Colliery.

The Wallsend Colliery. Abstracted from the *Newcastle Chronicle.* An account of a visit to this colliery which has been idle for a generation on account of being flooded, and is now being put in order for further working. 2000 w. Col Guard—Aug. 27, 1897. No. 15083 A.

Washing.

Coal Washing. Charles E. Bowron. A description of the coal washing and coking plant at Tracy City, Tennessee. 1000 w. Col Eng—Sept., 1897. No. 15348 C.

COPPER.

Assaying.

The Electrolytic Assay as Applied to Refined Copper. George L. Heath. Facts that have come under the writer's notice during an extended use of the method. 3500 w. Trans Am Inst of Min Engs—Sept., 1897. No. 15399 D.

Copper Mining.

Anaconda Copper Mining Company. Report of the trustees showing the operations of the company for the second year of its existence, with editorial analysis. 4000 w. Eng & Min Jour—Sept. 18, 1897. No. 15434.

Russia.

The Copper Industry in Russia. (L'Industrie du Cuivre en Russie.) Discussing the falling off in Russian copper production, and the possible means for its revival. 3500 w. Le Génie Civil—June 12, 1897. No. 15151 D.

GOLD AND SILVER.

Broken Hill.

Meeting of Broken Hill Proprietary Company, Limited, New South Wales. Address of chairman, Mr. E. Neale Wigg, showing what has been done during the past half year, and the plans for the future. 4400 w. Aust Min Stand—Aug. 5, 1897. No. 15356 B.

Colorado.

The Geology of Colorado. Arthur Lakes. A paper read before the Gold Convention, at Denver. The relation of geology to the ore deposits, and descriptions of formations in which the ores are found. 3500 w. Col Eng—Sept., 1897. No. 15347 C.

Cyanid Process.

Notes on Sump Solutions, Extractor-Box Work and Cleaning Up in the Cyanid Process. Alfred James. Abstract of a paper to be presented at the October meeting of the Institution of Mining and Metallurgy. Gives results of experiments made, concluding that increased extractions may be obtained by the proper treatment of sump solutions, or by the making up of fresh solutions. 2000 w. Eng & Min Jour—Sept. 11, 1897. No. 15268.

The Cyanid Process. Discussion of the papers of S. B. Christy, H. Van F. Furman, and George A. Packard. 9700 w. Trans Am Inst of Min Engs—Sept., 1897. No. 15393 D.

Dredging.

River Dredging for Gold. R. H. Postlethwaite. A résumé of dredging as carried out in the river Molyneaux, in New Zealand. 1500 w. Min & Sci Pr—Sept. 4, 1897. No. 15281.

Gold.

Alchemy Redivivus. Alexander E. Outerbridge, Jr. An account of the various efforts to obtain gold, and of investigations showing how widely this metal is diffused. 1200 w. Pop Sci M—Sept., 1897. No. 14994 D.

Gold: Its Origin and Law. Robert A. Moon. From the Melbourne *Argus.* Showing reasons for believing that gold may possess something of a fixed or natural mode of occurrence in stratified country. 1300 w. Aust Min Stand—Aug. 19, 1897. Serial. 1st part. No. 15599 B.

Gold. Showing that its physical characteristics differ from every other metal. 1000 w. Bos Jour of Com—Aug. 28, 1897. No. 14968.

Gold: Its Occurrence and Extraction. Joseph Campbell. Lecture delivered before the Melbourne Chamber of Commerce. Part first explains the nature of gold, the chemistry, the occurrence, &c. 4000 w. Aust Min Stand—July 15, 1897. Serial. 1st part. No. 15066 B.

Sending Gold to Market. "Crucible." Advises the melting of small parcels of gold before transporting, and explains how easily it may be accomplished by the use of plumbago crucibles. 1500 w. Aust Min Stand—Aug. 26, 1897. No. 15600 B.

Gold Excitement.

The World's Greatest Gold Excitement. Describes the scenes on the discovery of the Ballarat and Bendigo gold fields of Australia. 1800 w. Min Ind & Rev—Sept. 2, 1897. No. 15068.

Gold Fields.

Canada's Newest Gold Field. J. T. McDonald. An account of the discovery of auriferous quartz veins on the north shore of Lake Superior, in the vicinity of the Michipicoten River, with summary of the provisions of the mining act concerning manner in which mining claims may be acquired. 900 w. Eng & Min Jour—Sept. 25, 1897. No. 15582.

The Maldon Goldfield. R. A. Moon. Extracts from a special report issued by the Victorian Secretary for Mines. Describes what is claimed to be one of the most flourishing mining centers in Victoria. 3500 w. Aust Min Stand—July 22, 1897. No. 14987 B.

The Segovia Gold Region of Nicaragua. H. H. Miller. Description based on a very hasty visit to the region, calling attention to some of the interesting features. Ill. 2000 w. Eng & Min Jour—Sept. 18, 1897. No. 15433.

Gold Hunting.

Exploring and Exploiting a Gold Country. Albert Williams, Jr., Reflections and counsel suggested by the Klondike craze. 2800 w. Eng Mag—Oct., 1897. No. 15635 B.

Gold-Ores.

The Potsdam Gold Ores of the Black Hills of South Dakota. Frank Clemes Smith. An explanation of the classification used by the author, with description of the region, deposits, ores, &c. Map. 8800 w. Trans Am Inst of Min Engs—Sept., 1897. No 15403 D.

Gold Production.

The World's Gold Production. From the *New York Journal of Commerce*. Calls attention to the discoveries and improved processes of extraction which have given a new impulse to the production, and estimates the probable amount still to be extracted in certain fields. 1000 w. Sci Am Sup—Oct. 2, 1897. No. 15640.

Idaho.

An Idaho Klondike. Robert Bell. Presenting the great promise of this region and giving information of various districts. 3000 w. W Min Wld—Sept. 4, 1897. No. 15024.

Klondike.

Gold fields of Alaska and the Yukon. Cyrus C. Adams. Discusses matters of interest in relation to this region. The routes, desolation, types of mining, and important facts. 2800 w. Chau—Oct., 1897. No. 15605 C.

Life in the Klondike Gold Fields. Personal observations of Joe Ladue, the founder of Dawson, recorded by J. Lincoln Steffens. Ill. 3500 w. McClure's Mag—Sept., 1897. No. 14998.

News from the Klondike. Tappan Adney. The first of a series of letters with illustrations. Part first describes the fitting out at Victoria for the gold fields. 4000 w. Harper's Wk—Sept. 11, 1897. Serial. 1st part. No. 15025.

The Canadian Yukon Gold Fields. Review of the projected schemes for regulating the mining operations, improvement of the means of transport, &c., with other information of interest. Ill. 2500 w. Can Eng—Sept., 1897. No. 15328.

The Klondike Country. Editorial on the richness, character and resources of the country, and the rapid development sure to follow the mining excitement. 900 w. Min Ind & Rev—Sept. 16, 1897. No. 15511.

The Klondike Excitement Here and in London. Remarks on the causes affecting the enthusiasm, on the difficulties of the climate and facilities for transportation, &c. 700 w. Bradstreet's—Sept. 18, 1897. No. 15413.

The Klondike Goldfields. Harry de Windt. Comments on the dangers and difficulties of the region, gives a brief outline of the journey, information of the deposits and manner of working, scarcity of food, etc. 2500 w. Contemporary Rev—Sept., 1897. No. 15379 D.

The Klondike Gold Field. H. K. Carroll. Brief description of the country and account of the wonderful deposits, with outline of the two routes traveled. Ill. 2000 w. Sci Am Sup—Sept. 11, 1897. No. 15237.

The Yukon District. George M. Dawson. Some account of explorations made in this district, with information of the country and its resources. 1800 w. Can Min Rev—Aug., 1897. No. 15035 B.

The Yukon Mining Laws. Rossiter W. Raymond. Comments on and objections to the regulations governing placer-mining along the Yukon river and its tributaries, recently adopted by the Dominion Government. 2000 w. Can Min Rev—Aug., 1897. No. 15034 B.

Madagascar.

Gold in Madagascar. (L'Or à Madagascar.) Historical and geological account of the Madagascar gold fields, and method of working. Two articles. 7500 w. Le Génie Civil—May 1, 8, 1897. No. 15133 G.

New Mexico.

The Mineral Belt of the Mogollon Range. Carl Anderson. Describes the geology of the range and the peculiarities of the deposits. 2000 w. Eng & Min Jour—Sept. 4, 1897. No. 15208.

Oregon.

Eastern Oregon Gold Fields. E. G. Bailey. A statement of the condition of mining in this region. Ill. 1500 w. Min & Sci Pr—Aug. 28, 1897. No. 15007.

Peru.

Mining in the Department of Ancachs, Peru. F. J. Schafer. Brief reports of the different companies, giving mining conditions and general remarks on Ancachs. 2000 w. Eng & Min Jour—Sept. 4, 1897. No. 15207.

Precious Metals.

See same title under Economics and Industry, Currency and Finance.

Prospecting.

Notes on Prospecting. Jno. W. Gray. Directions for prospecting, with suggestions, appliances needed, things to be observed, &c. 3500 w. Min & Sci Pr—Sept. 11, 1897. No. 15364.

Slimes.

The Solution of Gold in Accumulated and Other Slimes. W. A. Caldecott. Read before the Chemical and Metallurgical Society of South Africa. Reviews the operations involved in dissolving the gold in slimes containing reducing substances, with some details of laboratory practice. 2300 w. Min & Sci Pr—Sept. 18, 1897. No. 15521.

Tasmania.

The Tasmania Mine. Illustrated description of the plant, and the work of the Lührig vanners. 1500 w. Aust Min Stand—July 29, 1897. No. 15067 B.

Veins.

Vein Intersections in Clear Creek County, Colo. James Underhill. Illustrated examples showing some of the causes that operate to make enrichments at intersections. 900 w. Eng & Min Jour—Sept. 18, 1897. No. 15435.

IRON AND STEEL.

Armor-Plates.

Tests of Armor-Plates. Report of tests giving information of considerable value in regard to surface cracks, laps, &c. 1000 w. Engng—Sept. 3, 1897. No. 15338 A.

The Carpenter Process for Making Armor Plate. A letter from J. H. Carpenter explaining the nature of the process, with editorial comment questioning the merits, and the correctness of the estimate of cost. 1400 w. Eng News—Sept. 16, 1897. No. 15377.

Comparative Armor Tests in Austria. (Essais Comparatifs en Autriche sur le Plaques de Blindage.) Discussing the results of test of armor plate of the various European makers with especial reference to hardened and non-hardened surfaces. 4500 w. Le Génie Civil—June 12, 1897. No. 15150 D.

Blooming Mill.

The American Blooming Mill. Ralph Crooker, Jr. Read before the Engineers' Soc. of W. Penna. Reviewing the conditions existing previous to the building of blooming mills, and gives the history of development in this industry in America. 6000 w. Ir Trd Rev—Sept. 23, 1897. No. 15522.

Charcoal Iron.

Southern Charcoal Iron. S. L. Graham. Discusses its manufacture for car wheel purposes from an economic standpoint. 3000 w. Tradesman—Sept. 15, 1897. No. 15419.

Cleaning Iron.

See same title under Civil Engineering, Bridges.

Gogebic Range.

Some Dike Features of the Gogebic Iron-Range. C. M. Boss. A short description of the characteristics and peculiarities of the principal dikes which have been exposed in this range. 3300 w. Trans Am Inst of Min Engs—Sept., 1897. No. 15394 D.

Hardening.

The Microstructure of Steel and the Current Theories of Hardening. Continued discussion of the paper of Mr A. Sauveur presented at the Colorado meeting, Sept., 1896. 14000 w. Trans Am Inst Min Engs—Sept., 1897. No. 15392 D.

Iron and Steel Industry.

The British Iron and Steel Industry during the Queen's Reign. Part first deals with the position of this industry in the early period of the reign. 1100 w. Ir & St Trds Jour—Sept. 18, 1897. No. 15540 A.

Iron Mining.

Methods of Iron Mining in Northern Minnesota. F. W. Denton. An illustrated description of the methods of mining employed. 9000 w. Trans Am Inst of Min Engs—Sept., 1897. No. 15404 D.

Iron Ore.

The Iron Ore Supply. John Birkinbine. Presented at the Lake Superior meeting of the Am. Inst. of Min. Engs. Shows the importance of the Lake Superior region as a contributor to the iron ore supply, its development and present status, and advances made elsewhere. 2800 w. Ir Age—Sept. 2, 1897. No. 15062.

Iron Preservations.

See same title under Architecture and Building, Miscellany.

Preserving Iron from Corrosion. Max Soltz. Conclusions from a paper read before the St. Paul Engineers' Assn. Describes a system which it is believed will protect iron and steel for a longer period than any other system now in use. 1000 w. Bos Jour of Com—Aug. 28, 1897. No. 14967.

Protective Coverings for Iron. Charles E. Koons. The necessity of smoothing rough surfaces before painting, and the right preparation and proper application are discussed. 1300 w. R R Car Jour—Sept., 1897. No. 15225.

Low-Carbon Steel.

The Connection between the Hardening Power and the Retardations of Low-Carbon Steel. Henry M. Howe. A comparison of the writer's results with those obtained by J. O. Arnold, and a reply to his remarks on work of the author. 1800 w. Eng & Min Jour—Sept. 25, 1897. No. 15581.

Open-Hearth.

Open-Hearth Steel and Its Manufacture by the Illinois Steel Company. T. L. Condron. Historical sketch with description of process and the work as carried on by this company. Ill. 4800 w. R R Gaz—Sept. 3, 1897. No. 15032.

The Bertrand-Thiel Modification of the Open-Hearth Process. J. S Robeson. A general description of the method, with some detailed facts in connection with it. Ill. 2200 w. Pro Engs' Club of Phila—July, Sept, 1897. No. 15251 D.

Ores.

The Development of Lake Superior Iron-Ores. D. H. Bacon. A short résumé of what has been done in this industry. 1400 w. Trans Am Inst of Min Engs—Sept., 1897. No. 15398 D.

Prices.

The Iron and Steel Boom of 1879 and 1880. A complete history of the celebrated boom from the annual report of James M. Swank, Secretary of the Iron and Steel Assn., dated May 20, 1880. 1500 w. Bul of Am Ir & St Assn—Sept. 10, 1897. No. 15321.

Steel Works.

The Sandvik Steel Works. Particulars of plant and operation. Ill. 1800 w. Ir & Coal Trds Rev—Aug. 27, 1897. No. 15204 A.

Testing.

The Influence of the Testing Method Upon the Result of Bending Tests at Low Temperatures. From *Stahl und Eisen*. Results of bending tests by M. Rudeloff, director of the Imperial German Testing Station. 700 w. Am Mfr & Ir Wld—Sept. 24, 1897. No. 15568.

Tires.

See same title under Mechanical Engineering, Miscellany.

Wrought Iron.

See same title under Electrical Engineering Miscellany.

MINING.

Accidents.

Accidents in American Metal Mines. Editorial comment on recently published statistics of the metal mines of Colorado, making comparison with the statistics for the United Kingdom. 1800 w. Eng & Min Jour—Sept. 4, 1897. No. 15206.

Brake.

Experiments with a New Checking Brake. (Versuche mit einer Neuen Bremsend Wirkenden Fangvorrichtung.) Giving the data of tests of a safety check for mine hoists. Teeth on eccentric sheaves engage with shaft timbers. 1600 w. 1 plate. Glückauf—September 4, 1897. No. 15190 D.

Explosives.

Explosives in 1896. Editorial review of the Annual Report of Her Majesty's Inspector of Explosives, noting the comparative safety in the factories, the character of the accidents, &c. 1600 w. Engng—Sept. 17, 1897. No. 15557 A.

Japanese Mines.

Some Japanese Mines. W. L. Austin. An interesting description of the primitive methods employed, some remarkable results in mining and treating low grade silver, gold and copper ores and other matters of interest. Ill. 3300 w. Col Eng—Sept., 1897. Serial. 1st part. No. 15346 C.

Mine-Dam.

A Mine-Dam. William Kelly. Describes a dam constructed in the Curry mine, at Norway, Mich., on the Menominee range, and the results. Ill. 1100 w. Trans Am Inst of Min Engs—Sept., 1897. No. 15395 D.

Mine Regulations.

Mine Regulations in Siberia. Regulations relating to fresh air, ventilation, shafts, &c. 1100 w. Am Mfr & Ir Wld—Sept. 17, 1897. No. 15420.

Mining Machines.

Increasing Use of Coal Mining Machines. Official figures, prepared by E. W. Parker, of the United States Geological Society, showing how machinery is superseding the pick. 1500 w. Am Mfr & Ir Wld—Sept. 3, 1897. No. 15231.

See same title under Economics and Industry, Labor.

Prussia.

Advances in Mining in Prussia in 1896. (Versuche und Verbesserungen beim Bergwerksbetriebe in Preussen während des Jahres 1896.) A very full review of improvements in tools, methods and appliances. Three articles. 1200 w. Glückauf—Aug. 21, 28, Sept. 4, 1897. No. 15187 G.

Roads

New Methods of Cutting Roads in Mines. Jules Collin. Translated from *Revue Universelle des Mines*. An endeavor to discover the most rapid way of accomplishing the work when blasting is not possible. Ill. 1200 w. Col Cuard—Sept. 17, 1897. No. 15565 A.

Shaft Sinking.

A New Freezing Process for Sinking Shafts. Brief description of a process invented by Louis Koch. Gaseous carbonic acid, ammonia, or a mixture of dioxide of sulphur, is circulated in specially constructed tubes whereby a degree of cold of from 40 to 60 degrees Cent. is generated and communicated to the ground. Ill. 700 w. Col Guard—Sept. 17, 1897. No. 15564 A.

Shaft Sinking near Wigan. C. M. Percy. Describes a very difficult piece of mining work. The sinking of pit-shafts through almost inexhaustible water feeders, extending to a substantial depth. 1300 w. Col Guard—Sept. 10, 1897. No. 15458 A.

MISCELLANY.

Aluminum.

Aluminum: A New Comer Among the Metals. The history of the early difficulties with this metal, the success and uses. 3800 w Am Rev of Revs—Oct., 1897. No. 15643 C.

Notes on Aluminum: The Relationship of its Cost of Production to its Use as a Conductor. John B. C. Kershaw. The use of aluminum as a conductor, in place of copper, in electrical construction work, and its bearing on the future development of the aluminum industry. 1200 w. Elect'n—Aug. 27, 1897. No. 15211 A.

The Aluminum Industry. A summary of the latest facts and figures available, relating to the production and cost of aluminum. 1000 w. Engng—Sept. 17, 1897. No. 15558 A.

Brass.

The Influence of Lead on Rolled and Drawn Brass. An account of the discovery that lead gives desirable cutting qualities to brass, with experimental study of its action. Ill. 7700 w. Trans Am Inst of Min Engs—Sept., 1897. No. 15402 D.

China.

The Mineral Resources of China. From the London *Mining Journal.* Information of the mineral deposits, of which coal is the more plentiful. 1700 w. Eng & Min Jour—Sept. 11, 1897. No. 15267.

Clays.

The Clays and Clay-Working Industry of Colorado. Heinrich Ries. Information of the clay bearing formations, in the belief that knowledge of the available materials will lead to an expansion of the clay-working industry of the state. 1800 w. Trans Am Inst of Min Engs—Sept., 1897. No. 15400 D.

Diamonds.

Diamonds in Steel. (Les Diamants dans l'Acier.) An account of the discovery of microscopic diamonds in steel, by Prof. Rossel, of Berne. 1600 w. Le Génie Civil—May 15. 1897. No. 15142 D.

Dynamite.

Conditions for the Installation of Underground Dynamite Magazines. From a report by the French Explosives Commission published in the *Annales des Mines.* Gives the principle of the arrangements originally proposed by the Commission, with experiments made and conclusions. 4500 w. Col Guard—Aug. 27, 1897. No. 15081 A.

Fullers' Earth.

The Fullers' Earth of South Dakota. An account of the deposits of Fuller's earth, which, next to Florida, are the most extensive thus far discovered in the United States. 800 w. Trans Am Inst of Min Engs—Sept., 1897. No. 15401 D.

Hand-Jig.

An Experimental Hand-Jig. Paul Buttgenbach. Describes an apparatus used for making preliminary tests previous to treating a large quantity of ore with machinery, and also for tests of samples. Ill. 800 w. Eng & Min Jour—Sept. 11, 1897. No. 15266.

La Plata.

The La Plata Mountains. Arthur Lakes. Where they are, what they look like, and their possibilities as a mining region. A description of the beginning of a laccolith, its progressive development into a mountain, and the influence of this kind of geological formation on the deposition of ores. Ill. 3500 w. Col Eng—Sept., 1897. Serial. 1st part. No. 15351 C.

Metallurgy.

The Metallurgical Industries of Canada. Abstract of a discourse by Prof. Roberts-Austen, at the meeting of the British Assn. in Toronto. The importance of the metals of the country, with much general information. 2700 w. Col Guard—Aug. 27, 1897. No. 15082 A.

Mine Waters.

Ferric Sulphate in Mine Waters and Its Action on Metals. L. J. W. Jones. Paper read before the Colorado Scientific Society. Gives experience at Idaho Springs, with experiments, analyses, &c. Also discussion. 2800 w. W Min Wld—Sept. 11, 1897. No. 15302.

Newfoundland.

The Undeveloped Mineral Wealth of Newfoundland. A. E. Outerbridge, Jr. Brief historical review of the discovery and information of the great variety of minerals. Ill. 3500 w. Jour Fr Inst—Sept., 1897. No. 15051 D.

Ovens.

The Principal Methods of Distillation of Wood. (Des Principal Methods de Distillation Du Bois.) A monograph, describing the various kinds of ovens used in Europe, with data of products and accounts of methods of operation. 7000 w. La Revue Technique—Aug. 25, 1897. No. 15123 D.

Petroleum.

The Production of Petroleum. Particulars derived from official and other sources, showing the state of the industry in some of the principal petroleum-producing countries. 2800 w. Bd of Trd Jour—Sept., 1897. No. 15542 A.

Production.

Production of Lead and Zinc in 1896. Charles Kirchhoff. From the Annual Report of the U. S. Geological Survey. Tabulated statements of the total gross production since 1873, with comment. 900 w. Am Mfg & Ir Wld—Sept. 24, 1897. No. 15569.

Rare Metals.

The Rare Metals. Some metals worth more than gold, on account of their scarcity. 700 w. Min Ind & Rev—Sept. 9, 1897. No. 15353.

Southern United States.

The Mining and Metallurgical Industries of the Southern States. Part first relates to the mining of iron ores, and gives illustrations of the mines in Alabama, with details of the economic conditions. 2000 w. Ir & Coal Trds Review—Sept. 3, 1897. No. 15308 A.

Titanium.

Titanium and its Compounds. (Le Titane et ses Composés.) A discussion of the treatment of titaniferous ores in the blast furnace, by M. Auguste Rossi. Three articles. 10000 w. Le Génie Civil—June 26, July 3, 10, 1897. No. 15156 H.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Solutions of Acetylene and Their Explosive Properties. Messrs. Berthelot and Vieille. Read before the Academie des Sciences, Paris. A study of the properties of acetylene solutions. 2500 w. Pro Age—Sept. 1, 1897. No. 14999.

Ammonia.

The Agricultural Value of Sulphate of Ammonia. Extracts from the discussion of F. J. R. Carulla's paper. 4000 w. Jour Gas Lgt—Sept. 14, 1897. No. 15520 A.

Burner.

Development of an Atmospheric Burner. A. Bandsept. A pamphlet upon an auto-mixing "atomizing" burner for combustion of high intensity. Statement of the principles with illustrated description of burners and their action. 5000 w. Pro Age—Sept. 15, 1897. No. 15366.

The Bandsept Incandescent Burner. A. Bandsept. Abstract of a paper read before the Belgian Assn. of Gas Fitters. Description with experiments and results. 1400 w. Pro Age—Sept. 1, 1897. No. 15000.

Bye-Products.

Dr. Bunte on Bye-Products and Auxiliary Materials. Translation from the *Journal für Gasbeleuchtung*, slightly abbreviated, of a paper presented at the meeting of the German Assn. 1700 w. Jour Gas Lgt—Aug. 31, 1897. No. 15255 A.

Coal Gas.

Notes on the Enrichment of Coal Gas. The first of a series of articles making a study of methods of enrichment. 3200 w. Jour Gas Lgt—Sept. 7, 1897. No. 15358 A.

The Early Days of Gas. Articles from the *Dundee Advertiser*. The history of the discovery of coal gas and its earliest use as an illuminant. 1500 w. Gas Wld—Aug. 28, 1897. No. 15091 A.

Convention.

The Technical Society of Gas Manufacture in France. (Société Technique de l'Industrie du Gaz en France.) A report of the Convention of the French Gas Light Association recently held in Paris discussing many questions of current interest. Two articles, 4000 w. Le Génie Civil—June 26, July 10, 1897. No. 15157 G.

Denver, Colo.

Mayor McMurray's Veto of the Opposition Charter for Denver, Colo. Text of the veto under which the mayor disapproves the action of the Denver City Council, in granting a franchise to the projectors of an opposition gas works. 4000 w. Am Gas Lgt Jour—Sept. 20, 1897. No. 15436.

Fuel Gas.

Gas as Fuel. F. Foveaux. Read before the Pacific Coast Gas Assn. A report of investigations made to improve the methods by which gas is burned in ordinary stoves. Followed by discussion. Ill. 2200 w. Am Gas Lgt Jour—Aug. 30, 1897. No. 14976.

Furnace.

The Rouen Furnace for Carbonic Oxide. (Four à Oxyde de Carbone dit "Four de Rouen.") An illustrated description of the improved regenerative gas furnace for heating gas retorts by producer gas. 2500 w. Le Génie Civil—May 8, 1897. No. 15137 D.

Gas Producer.

The Kitson Gas Producer. John E. Fry. Enumerates the evils which the operator of the ordinary gas producer encounters, explains the principles involved, and describes the mechanism of the Kitson producer, and its operation. 6000 w. Ir Age—Sept. 30, 1897. No. 15627.

Gas Undertaking.

A Descriptive Sketch of the Elland-Cum-Greetland Gas Undertaking. Address of Robert Porter to the Manchester District Institution of Gas Engineers. Also description of the coal elevating and conveying machinery used. Ill. 4000 w. Jour Gas Lgt—Aug. 31, 1897. No. 15254 A.

Great Yarmouth.

Electricity and Gas in Great Yarmouth. W. J. Carpenter. Read before the Eastern Counties Gas Managers' Assn. Describes the electricity works, reports progress in both electricity and gas. Discussion. 4000 w. Gas Wld—Sept. 11, 1897. No. 15425 A.

Hydraulic Mains.

A Difference in Hydraulic Mains. P. Egan. Read at North of Ireland Assn. of Gas Managers, and followed by discussion. Treats of pitched mains and choked ascension-pipes. 2000 w. Jour Gas Lgt—Aug. 24, 1897. No. 15012 A.

Indiana Gas.

Gas in Indiana. From the Indianapolis *Journal*. On the situation in Indiana gas affairs, and the changes that have taken place during the past ten years. 1300 w. Pro Age—Sept. 15, 1897. No. 15367.

Naphthalene.

Young and Glover's Naphthalene Remedy. Reproduction of the patent specification. 2500 w. Gas Wld—Sept. 11, 1897. No. 15427 A.

Natural Gas.

Natural Gas Production in the United States. From advanced sheets of the Eighteenth Annual Report of the United States Geological Survey. Report of the production for 1896, with the condition of the fields, value of the gas, consumption and distribution. 2000 w. Am Mfr & Ir Wld—Sept. 17, 1897. No. 15421.

Philadelphia Gas.

Private Control of Gas in Philadelphia. A statement of the condition of affairs. Poor gas, poor works, poor management under municipal control, and the offers of private companies to make all necessary improvement at great cost, yet sell the gas cheaper than under the present management. 4400 w. Pro Age—Sept. 15, 1897. No. 15369.

Purifying Houses.

Noxious Air in Purifying Houses. Comments on some recent researches by Herr H. Drehschmidt, the chemist of the Berlin Municipal Gas-Works, with some of the technical results arrived at in the investigations. 3000 w. Jour Gas Lgt—Aug. 31, 1897. No. 15253 A.

Regenerative Settings.

Experiences with Regenerative Settings. Frank Prentice. Read before the Eastern Counties Gas Managers' Assn. A record of troubles and partial failures. Followed by discussion. 4200 w. Jour Gas Lgt—Sept. 14, 1897. No. 15519 A.

Solutions.

Solutions of Solids in Gases. M. P. Villard. Summary of a communication to the French Physical Society. Experiments showing that gases possess the property of dissolving liquids or solids under ordinary circumstances. 2000 w. Gas Wld—Sept. 4, 1897. No. 15322 A.

Street Lighting.

Street Lighting by Incandescent Gas Burners. C. R. Bellamy, superintendent of the Liverpool Corporation, reports concerning the Incandescent gas burner (Welsbach patent). States advantages, difficulties encountered and overcome, with results, and describes the lamp. Ill. 1600 w. Gas Wld—Sept. 11, 1897. No. 15426 A.

SEWERAGE.

Flow.

The Methods and the Results of Experiments for the Determination of the Velocity of the Flow of Water, under Direction of the Bureau of Surveys, City of Philadelphia. Charles Jacobsen. Describes experiments illustrating the work being done under the direction of the Bureau of Surveys, to determine the size of sewers, the velocity of the flow of water, and the relative percentage of the amount of rainfall which would reach the sewer. Discussion follows. Ill. 6000 w. Pro Engs' Club of Phila—July-Sept., 1897. No. 15248 D.

Regulatory Acts.

Regulatory Acts by City Councils. The Indianapolis and other cases. Reviews recent attacks by municipalities on gas corporations, with editorial comment. 7000 w. Pro Age—Sept. 15, 1897. No. 15365.

Sewers.

Heavy Sewer Work. Describes the construction of brick sewers in the twenty-third and twenty-fourth wards of New York city. 1100 w. Eng Rec—Aug. 28, 1897. No. 14980.

Operation of the Los Angeles Outfall Sewer and Sewage Irrigation. Burr Bassell. A brief description of the sewer with account of its operation, and of the sewage irrigation and its results. Discussion follows. Ill. 7800 w. Jour Assn of Engng Soc—Aug., 1897. No. 15301 C.

Separate Sewage Systems. (Ueber Trennungssysteme.) A discussion by Chief Engineer Metzger, of Bromberg, of the status of the separate system in Germany, with sections of double-channel sewers. 7500 w. Gesundheits Ingenieur—August 15, 1897. No. 15172 B.

Sewer Outlets in Springfield, Mass. Brief illustrated description of the construction of three sewer outlets in the Connecticut river. 500 w. Eng Rec—Sept. 11, 1897. No. 15330.

The Round Hill Street-Sewer Tunnel in Waterbury, Conn. Detailed description of the construction of a sewer tunnel, necessarily built very deep. Ill. 1500 w. Eng Rec—Aug. 28, 1897. No. 14979.

Sewage.

Recent Developments in Sewage Purification. Gilbert Thomson. An address at the opening of the Sanitary Association of Scotland. Discusses the three chief methods in use at the present time—on land, by precipitation, and by bacteriological methods. 1600 w. Arch, Lond—Sept. 3, 1897. No. 15310 A.

The Biological Purification of Sewage. W. J. Dibdin. Gives the history of the process, the work of the Barking filter, the Sutton filter, the septic tank system, and discusses the future developments. 1800 w. Prac Eng—Sept. 10, 1807. No. 15424 A.

The Sewage-Disposal Plant at Altoona, Pa. Harvey Linton. Describes the location and conditions at Altoona, with the work in preparing for filtration. Tabulated statements of all pids received are given, wlth a general map and profile view of the sewer, and the eastern sewage carrier, in the filter bed, &c. 5500 w. Pro Engs' Club of Phila—July-Sept., 1897. No. 15247 D.

The Sewage Problem. Editorial discussion of how to deal with sewage in England. The self-purifying process in operation in Sutton (Surrey) District Council is favorably reported. 1800 w. Prac Eng—Sept. 10, 1897. No. 15423 A.

Treatment of the Effluent from Sewage Precipitation Works. Kenneth Allen. Presents the frequent necessity of subsequent purification, giving the methods used in numerous foreign cities, and data furnished by recent investigators. 3400 w. Munic Engng—Sept., 1897. No. 15021 C.

Sewage Farm.

A Visit to a New Sewage Farm at Berlin. Allen Hazen. Photographs taken during the visit are given and described. All the sewage is treated by applying it to land. 1500 w. Eng News—Sept. 16, 1897. No. 15375.

Sewage Lift.

Adam's Patent Sewage Lift. Illustrated description of invention to meet the difficulty of lower levels. 900 w. Ind Engng—Aug. 21, 1897. No 15494 D.

STREETS AND PAVEMENTS.

Asphalt Paving.

A New Development in Machinery for Asphalt Paving. Illustrated description of a portable plant for practical work, invented by Frederick A. Hetherington, of Indianapolis, Ind. 1400 w. Sci Am—Oct. 2, 1897. No. 15620

Asphalt and Asphalt Pavements. George W. Tillson. Slightly abbreviated from a paper read before the Am. Soc. of Civ. Engs., May 5, 1897. Discusses asphalt in the forms used for pavements, and the various questions related to its use. 8500 w. Eng News—Sept. 2, 1897. No. 15019.

Municipal Maintenance of Asphalt Pavements. Edward P. North. Gives the specifications for maintenance in New York City, and discusses the difficulties. 1100 w. Eng Rec—Sept. 4, 1897. No 15041.

Utah and Kentucky Asphalt Pavements. Information condensed from a number of sources. 1800 w. Eng Rec—Sept. 4, 1898. No. 15040.

Omaha.

The New Paving Specifications of Omaha. Copy of the forms for submitting bids and the classification of work, as prepared by the city engineer. 3500 w. Munic Engng—Sept., 1897. No. 15023 C.

St. Louis.

Streets of St. Louis. Information of the paving used in the improved streets, with the specifications for the brick paving. Ill. 1000 w. Brick—Sept., 1897. No. 15020.

Street Cleaning.

The Cleaning of a Great City. George E. Waring, Jr. Describes the former condition of New York streets, and their improved present condition. The reorganization of the department, disposing of refuse, &c. 6000 w. McClure's Mag—Sept., 1897. No. 14997.

WATER SUPPLY.

Croton Aqueduct.

The Croton Aqueduct Embankment. H. K. Landis. Improvements made necessary the piercing of the Old Croton Aqueduct, and a view of the embankment is given, with historical review of the work. 1100 w. Eng News—Sept. 9, 1897. No. 15270.

Hydraulics.

An Interesting Hydraulic Experiment. Marvin E. Sullivan. Gives experiment demonstrating that the flow in small pipes follows the same law in all dimensions. 1000 w. Min Ind & Rev—Sept. 16, 1897. No. 15512.

Hydrostatic Pressure.

The Internal Hydrostatic Pressure in Masonry, with Especial Reference to Masonry Dams. Arnold Emil Broenniman and Harry Hurson Ross. Gives a series of experiments, describing apparatus used and method of testing, showing that water pressure is transmitted through ordinary stones, and through dams and how it may affect the stability, and gives some of the possible means of reducing or eliminating the effect. Ill. 13000 w Jour of Soc of W Engs—Aug., 1897. No. 15611 D.

Pressures.

Pressures Resulting from Changes of Velocity of Water in Pipes. J. P. Frizell. A record of experiments and results. 2300 w. Pro Am Soc of Civ Engs—Aug., 1897. No. 14996 F.

Pumping Plant.

Test of High Duty Pumping Plant. Dabney H. Moury, Jr. Describes the test of the plant of the Peoria Water Co., with brief description of changes made and the results obtained. Ill. 2500 w. Fire and Water—Sept. 4, 1897. No. 15044.

Reservoirs.

New Reservoirs of the Minneapolis Water-Works. Illustrated description of the work in progress for the improvement and increase of the water supply of the city. 2400 w. Eng Rec—Sept. 11, 1897. No. 15329.

Simla.

The Simla Water-Supply. Information from the Annual Report of the Simla Municipality regarding the working of the water-supply system, and the proposed extension of the works. 2400 w. Ind Engng—Aug 21, 1897. No. 15495 D.

Stream Flow.

Observations on Rain Fall and Stream-Flow in Eastern Pennsylvania. John E. Codman. Discusses the quantity of water available from a given watershed, either as a source of water supply or water power. 4200 w. Pro Engs' Club of Phila—July-Sept., 1897. No. 15252 D.

Water-Pipe.

Recovering a Line of 24 and 30-in. Cast-Iron Water-Pipe at Boston. Frederic I. Winslow. Changes in street grades made necessary the relaying of some large water mains, and it was decided to raise the old pipes for future use. The method employed is described. Also a similar piece of work elsewhere. 1200 w. Eng News—Sept. 9, 1897. No. 15271.

Water-Rates.

Comparison of Water Rates and Rules. Information collected by Dabney H. Maury, Jr., superintendent of the Peoria Water Co., regarding the rules, rates, and general practice in American cities. 3000 w. Munic Engng—Sept., 1897. No. 15022 C.

Water-Works.

City of Birmingham Corporation Water-Works. Henry Davey. Part first gives an historical account of the water supply since 1826, the present supply, and the interim resources. 1500 w. Mech Wld—Aug. 27, 1897. Serial. 1st part. No. 15076 A.

I. Notes and Distribution. J. Shaw. II. Electrical Water-Level Recorders. W. Coles Finch. Abstracts of two papers read before the British Assn. of Water Works Engs., with discussion. The first paper describes an ideal service reservoir, and discusses the factors which have to be considered in laying out the distributing mains. The second describes the construction and use of instrument named. 4300 w. Jour Gas Lgt—Aug. 24, 1897. No. 15013 A.

MISCELLANY.

Address.

Presidential Address before the Congress of the Sanitary Institute at Leeds, Eng. Dr. Robert Farquharson. He discusses the progress of hygiene, defects of civilization, increase of new diseases, value of light, housing and health questions. 4400 w. Arch, Lond—Sept. 17, 1897. No. 15567 A.

Baths.

Birmingham (Eng.) Baths. Information from a book prepared by J. Cox, superintendent and engineer of the baths department, giving a history of the public baths, their cost, maintenance, &c. 2000 w. Arch, Lond—Sept. 10, 1897. No. 15446 A.

Conveniences.

See same title under Architecture and Building, Plumbing and Gas Fitting.

Dust Cart.

A Steam Dust Cart. Description, with illustration, of a composite vehicle in use in Chiswick. 1500 w. Engng—Sept. 17, 1897. No. 15552 A.

Garbage.

Treatment of Household Garbage in Philadelphia and New York. (Traitmente des Ordures ménagères á Philadelphie et à New York.) Discussing the feasibility of introducing an incinerating plant in Paris, similar to those used in the American cities. 4500 w. Le Génie Civil—June 5, 1897. No. 15148 D.

Municipal Restaurant.

The Municipal or Co-operative Restaurant of Grenoble, France. C. Osborne Ward. An account of a restaurant owned and indirectly managed by a city with unquestioned success for a period of forty-five years. 3500 w. Bul of Dept of Labor—Sept., 1897. No. 15406 D.

Piers.

Recreation Piers. Edward C. O'Brien. Describing the opening of one such pier, and plans concerning others. 2200 w. Munic Aff—Sept. 1897. No. 15946.

Twentieth Century City.

The Problem of the Twentieth Century City. Josiah Strong. Discusses the growing increase of population in cities and the changed conditions causing this concentration. 2200 w. N Amer Rev—Sept., 1897. No. 14989 D.

Reform.

The progress of Municipal Reform. Clinton Rogers Woodruff. Address delivered at the Louisville Conference for Good City Government. Reviews the principal achievements of the more active organizations and draws conclusions. Considers the outlook promising. 6000 w. Munic Aff--June, 1897. No. 15952 C.

Refuse.

The Willoughby Refuse Destructor. Illustrated description of a destructor that has been working with satisfaction at Lewisham, Eng. It consists essentially of a furnace and a revolving cell. 800 w. Eng, Lond—Sept. 17, 1897. No. 15547 A.

RAILROAD AFFAIRS.

NEW CONSTRUCTION.

Africa.

The Railways of Equatorial Africa. Particulars about railway building in the Soudan, and information of other railways existing and projected. 3800 w. Trans—Sept. 17, 1897. No. 15575 A.

Electric Railway.

The Auxiliary Electric Railway at Meckenbeuren-Tettnang. (Die Elektrische Nebeneisenbahn Meckenbeuren-Tettnang.) Illustrated description of a special "feeder" line operated in connection with steam road. Part I. 4000 w. Zeitschr d Ver Deutscher Ing—Sept. 4, 1897. No. 15112 D.

Extension.

Railway Extension in Dumbartonshire. Illustrated description of interesting construction work. 2400 w. Engng—Aug. 27, 1897. No. 15080 A.

India.

The Mushkaf Bolan Railway, Baluchistan, India. James Ramsay. Describes the Bolan Pass and the railway projects of this region. 5500 w. Ind & East Eng—Aug. 14, 1897. Serial. 1st part. No. 15282 D.

Rack Railways.

Progress in the Perfection of the Rack Railway. E. L. Corthell. Tracing the origin of rack-bar railroads, and describing in detail the project of the Jungfrau road. Ill. 4700 w. Eng Mag--Oct., 1897. No. 15636 B.

Tunnels.

The Hamilton Tunnel. Description and illustrations of design, methods of construction and plant installed. 4700 w. Eng Rec—Aug. 28, 1897. No. 14997.

The Tunnels of the First Division of the Mushkaf-Bolan Railway, India. William Arthur Johns. Describes the construction of the six short tunnels found necessary by the route traversed, with statement of cost. 3000 w. Ind & East Eng—Aug. 28, 1897. Serial. 1st part. No. 15602 D.

MAINTENANCE OF EQUIPMENT.

Axles.

Discussion on Axles. R. A. Mould. A paper read before the National Railway Master Blacksmiths' convention. Advocates steel axles. Also a statement of the superiority of iron axles, as presented in a paper by George F. Hinkens. 3500 w. Ry Rev—Sept. 11, 1897. No. 15291.

Box Cars.

New Box Cars for the Chesapeake and Ohio. Illustrated description. 1200 w. R R Gaz—Sept. 3, 1897. No. 15030.

Brake Levers.

Standard Brake Levers. Pulaski Leeds. Discusses the advantages of standards, and the unmechanical system now in use. 2200 w. R R Car Jour—Sept., 1897. No. 15219.

Brake Shoes.

A Contribution to the Theory of Brake Shoes. Letters called out by article published Aug. 27, with editorial discussion. 2500 w. R R—G az Sept. 24, 1897. No. 15526.

Caboose.

Improved Caboose for the Lake Shore and Michigan Southern Railway. Illustrated description of cars designed by A. M. Waitt, showing a greater degree of convenience by careful arrangement and some innovations in construction. 800 w. Ry Rev—Sept. 25, 1897. No. 15594.

Car Lighting.

The Lighting of Railway Cars. H. Gordes. Read before the Assn. of German Technical Engineers. Part first discusses briefly the various kinds of illumination, especially the electric light and Pintsch gas. 2700 w. Pro Age—Sept. 15, 1897. Serial. 1st part. No. 15368.

The Lighting of Trains by Acetylene. (Eclairage des Trains à l'Acétylène.) Discussing the various experiments made in Germany and France, and recommending a mixture of acetylene and nitrogen as being safe under pressure as well as efficient and economical. 5000 w. Le Génie Civil—July 3, 1897. No. 15160 D.

Cars.

Carriages for the South-Eastern Railway. Illustrations, with description of the interior work of the cars composing the new vestibule train for the Continental Express. 1500 w. Engng—Sept. 17, 1897. No. 15553 A.

Corridor Carriages for the Eastern Railway of France. Illustrated description. 1100 w. Engng—Sept. 10, 1897. No. 15460 A.

Hospital Car on the Long Island Railway. Brief illustrated description of a nicely fitted hospital car for use at a wreck. 500 w. Ry Rev—Sept. 25, 1897. No. 15596.

New South Wales Railways. Passenger Carriages. Information of the passenger vehicles added during the term of office of the present Railway Commissioners. Ill. 1700 w. Eng, Lond—Aug. 27, 1897. No. 15086 A.

New Trains on the C. B. & Q. Railroad. Illustrated description of two handsome trains of cars, said to be probably the finest built in any country, with the exception of the World's Fair train. 500 w. R R Car Jour—Sept., 1897. No. 15221.

Refrigerator Cars for the Colorado Midland Railroad. Illustrated description of cars for the handling of perishable freight. 1500 w. Ry Rev—Sept. 4, 1897. No. 15215

The English Royal Train. Brief illustrated description of the carriages recently built for the use of the Queen of England. 700 w. R R Car Jour—Sept., 1897. No. 15223.

Grates.

Locomotive Grates. Condensed report of the committee of the Am. Ry. Mas. Mach. Assn. Ill. 5500 w. Ry Rev—Sept. 4, 1897. No. 15217.

Locomotives.

An Electric Railway Locomotive. Illustrated description of a locomotive adapted to be used on ordinary railways for shunting and other miscellaneous work, recently constructed by the Allegemeine Elektricitäts-Gesellschaft, Berlin. 1300 w. Elec Rev, Lond—Sept. 17, 1897. No. 15580 A.

Brooks' Twelve-Wheelers for the Buffalo, Rochester & Pittsburg. Engraving, elevation and sections with dimensions and description. 700 w. R R Gaz—Sept. 24, 1897. No. 15527.

Compound Locomotives of the Russian State Railway. (Die Verbund-lokomotiven der Preussischen Staatseisenbahn.) Discussing a great variety of starting valves and mechanism for compound locomotives. 1 plate. 8000 w. Glaser's Annalen—August 1, 1897. No. 15168 D.

Compound Locomotive with Four Cylinders. (Verbund-locomotive mit Vier Dampfcylindern.) An illustrated description of von Borries latest design of compound locomotive. Four cylinders with separate cranks, but combined valve gear, give excellent distribution. 2500 w. Glaser's Annalen—August 15, 1897. No. 15170 D.

Cupped Fire-Box Sheets for Locomotives—Chicago, Rock Island and Pacific Ry. An application of the method of Joseph Cour, aiming at greater flexibility of the fire-box sheet and getting the stay-bolt ends less exposed to the fire. 1100 w. Ry Mas Mech—Sept., 1897. No. 15036.

How a Model Locomotive Was Made. Illustrated description of a model of a locomotive belonging to the D 2 class of the London, Brighton and South Coast Railway. It was built by J. Bradbury Winter, at Brighton, and the undertaking has occupied nearly thirteen years. The scale is 1 in. to the foot. 3500 w. Eng, Lond—Sept. 17, 1897. No. 15546 A.

Locomotive Improvement. Editorial review of recent discussions on this subject. 1200 w. Am Eng & R R Jour—Sept., 1897. No. 14984 C.

Passenger Tank Locomotive; Lung-Wu Railway, China. General dimensions and description of locomotives built for this line, by the Brooks Locomotive works. Ill. 700 w. Eng News—Sept. 9, 1897. No. 15275.

Sumatra Rack Railway Locomotives. D. L. Graadt van Roggen. Some information of rack railway construction with detailed description of the locomotives. Ill. 3000 w. Engng—Sept. 3, 1897. No. 15337 A.

The Heilmann Electric Locomotive. Illustrated description of this locomotive since recent improvements have been made. 1400 w. Sci-Am—Sept. 4, 1897. No 15008.

The Mathematics of the Performance Sheet. George S. Hodgins. Discusses the imperfections of these records and suggests that the element of time be included, producing as the term of work done the "ton-mile per hour." 2300 w. Ry Mas Mech—Sept., 1897. No. 15037.

Serpollet System.

The Application of the Serpollet Traction System to Main Line Service. (Application du Système de Traction Serpollet à des Wagons Automoteurs de Grandes Lignes.) The Serpollet motor cars have been applied to the Würtemberg railway and also to the Paris, Lyons-Mediteranée system successfully for local traffic. 4000 w. 1 plate. Le Génie Civil—June 22, 1897. No. 15149 D.

Spark Arrester.

Bell's Spark Arrester on the Baltimore and Ohio. Illustrated description of the essential features of the latest type of this device. 600 w. R R Gaz—Sept. 10, 1897. No. 15279.

Unloading.

Tipping Apparatus for Car Unloading. (Appareil Basculeur pour le Déchargement des Wagons.) An illustrated account of the Roisin unloader, with plate showing its arrangement in connection with conveyors at the beet root sugar works of M. Bouchoire. 3000 w. 1 plate. Le Génie Civil—June 5, 1897. No. 15147 D.

Vestibule Train.

New Vestibule Train for the South-Eastern Railway Company, England. Description and dimensions of cars. 1100 w. Engng—Sept. 10, 1897. No. 15465 A.

Weed Burner.

The Atchison Weed Burner. Plan and vertical section of the railroad weed burner in use on the Atchison, Topeka and Santa Fé, with description of operation. 800 w. R R Gaz—Sept. 10, 1897. No. 15277.

MAINTENANCE OF WAY.

Coal Depot.

The New Midland Coal Depot at St. Pancras. Notes on the progress of the work since April, 1896, with a plan of the high and low level of the depot. 700 w. Col Guard—Sept. 10, 1897. No. 15454 A.

Rails.

Effect of Handling on the Life of Rails. H. K. Landis. Discusses the influences which affect the service of a rail, showing that high carbon steel should be carefully handled. 1500 w. Ry Age—Aug. 27, 1897. No. 14970.

Why Rails Break in Track. Editorial discussion of this subject, with a statement of conditions that must be satisfied in order that a rail shall not break in service. 2200 w. Am Eng & R R Jour—Sept., 1897. No. 14985 C.

Rail Fastenings.

Automatic Rail Chairs. (Automatisch wirkender Schienenstuhl.) The Chenu rail chair is arranged with an automatic clamp which utilizes the weight of the train upon the rail to tighten its hold. 1500 w. Zeitschr d Oestrr Ing u Arch Ver—August 20, 1897. No. 15128 B.

Station.

New Railway Station for the Chantilly Race Course. (La Nouvelle Gare des Courses a Chantilly.) A description of a station adapted for prompt handling of large numbers of people; with plate showing arrangement of tracks and system of signals. 3000 w. La Revue Technique—August 10, 1897. No. 15116 D.

Ties.

The Chemical Preservation of Cross-Ties. From the report of the committee at the annual meeting of the Am· Soc. of R. R. Supts. at Nashville, Tenn. Shows the economy due to use of preservatives, and quotes tables from the report of E. E. Russell Tratman. 900 w. Ry Rev—Sept. 25, 1897. No. 15595.

Washouts.

Washouts on the St. Paul and Duluth R. R. and Methods for Repairing. Describes the damage done and how some of the difficulties were met, showing the promptness with which obstructions are removed. Ill. 2500 w. Ry Rev—Sept. 11, 1897. No. 15292.

SIGNALING.

Derailing.

Electric Locks for Derails at Crossings. Diagram showing arrangement of instruments and circuits, with description furnished by Mr. Hansel, general manager of the National Switch and Signal Co. 1300 w. R R Gaz—Sept. 10, 1897. No. 15276.

The Derailed Switch as a Moral and Physical Safety Device. Charles Hansel. Abstract of a paper read at the meeting of the Railway Signaling Club, New York. Also the "Proposed Signals at Passaic River Drawbridge, West Arlington, N. J.," as planned by Mr. Hansel are described. 2500 w. R R Gaz—Sept. 17, 1897. No. 15411.

Signal Lanterns.

Railway Signal Lanterns. (Lanternes de Signaux pour Chemins de Fer.) Experiments on the visibility of signal lights with various arrangements of reflectors. 3000 w. Le Génie Civil—May 8, 1897. No. 15136 D.

Signaling.

Why Automatic Road-Crossing Signaling Apparatus Fails. V. K. Spicer. Considers the various devices for protecting road crossings, and calls attention to the care and watchfulness necessary. 1000 w. Am Eng & R R Jour Sept., 1897. No. 14983 C.

TERMINALS AND YARDS.

New Shops.

The New Shops of the Peoria & Eastern at Urbana. Description of the new shops and yards now being built, with general plan, sections, etc. 2000 w. R R Gaz—Sept. 24, 1897. No. 15529.

TRANSPORTATION.

Accidents.

Train Accidents in the United States in July. Detailed list and classified summary. 3400 w. R R Gaz—Sept. 3, 1897. No. 15029.

Africa.

Cape Railways. A report of the results which, in spite of the difficult conditions, show a surprising degree of prosperity. 1000 w. Engr, Lond—Sept. 17, 1897. No. 15551 A.

Cromer Express.

The Run of the Cromer Express—Great Eastern Railway. A. M. B. Describes the fast run of a train hauled by an oil-fired engine. Ill. 1800 w. Engr, Lond—Sept. 17, 1897. No. 15550 A.

Differentials.

Differential Rates and Excess Fares. Facts given to throw light on the question of regulating competition, with editorial discussion of the general principles involved. 3500 w. Ry Age —Sept. 3, 1897. No. 15213.

Earnings.

August's Heavy Railway Earnings Increases. The most encouraging report of railway operations given for any month for a number of years. 1500 w. Bradstreet's—Sept. 11, 1897. No. 15318.

Prussia's Railroad Earnings. Consular report of the enormous sums earned by the railways under government ownership. 500 w. Cons Repts—Oct., 1897. No. 15389 D.

Freight.

Faster and Heavier Freight Trains and Economical Freight Movement. Editorial on the remarkable record of the Chesapeake and Ohio R. R. in the movement of freight at low cost. 1500 w. Eng News—Sept. 9, 1897. No. 15272.

Locomotive Driving.

The Economical Driving and Firing of the Locomotive Engine. R. M. Deeley. Deals with the various points that effect the economical working of the locomotive engine, as much depends on the methods of firing and working adopted. 4700 w. Eng, Lond—Sept. 10, 1897. No. 15437 A.

Pooling.

Pooling of Freight Equipment. J. R. Cavanagh. Presents causes that show the necessity of considering this problem, and claims for the pooling of freight equipment. Also editorial. 2800 w. R R Car Jour—Sept., 1897. No. 15220.

Rapid Transit.

The Enormous Possibilities of Rapid Electric Travel. Charles Henry Davis and F. Stuart Williamson, Showing in detail the possibility of bringing Philadelphia within thirty-six minutes of New York harbor. Ill. 4900 w. Eng Mag—Oct., 1897. Serial. 1st part. No. 15632 B.

Rates.

Carload versus Pounds as a Rate Basis. Editorial on the demands of the Kansas cattle shippers, giving a brief history of the controversy. 800 w. Ry Age—Aug. 27, 1897. No. 14969.

Differential Rates and Excess Fares. Some further considerations of the problem, with map of standard lines and connections between Chicago and New York. 1700 w. Ry Age—Sept. 10, 1897. No. 15305.

Regulation.

A Decade in Federal Railway Regulation. H. T. Newcomb. Discusses the causes that led to the passage of the Interstate Commerce Law, and the measure of success that has resulted in the ten years since its enactment. 3500 w. Ap Pop Sci M—Oct., 1897. No. 15645 D.

Transportation.

Retrospective and Prospective. W. G. Creamer. Discusses the material advances made in transportation methods, and calls attention to "little things" which would add greatly to the comfort and safety of passengers. 1300 w. R R Car Jour—Sept., 1897. No. 15224.

Transshipment.

Narrow Gauge Light Railways and How to Avoid Transshipment. Everard R. Calthorp. A letter to the editor from the consulting engineer of the Barsi Light Railway. Describes a transportation car, by means of which standard gauge cars of all kinds can be carried over a narrow gauge line. 1400 w. Trans—Sept. 17, 1897. No. 15574 A.

MISCELLANY.

Address.

Address of E E. Russell Tratman, before the Roadmasters' Association. Extracts from the address, touching on wheels, rails, track, &c. 4000 w. Ry Age—Sept. 24, 1897. No. 15573.

British Railroads.

British Railroads for 1896. Editorial on the railway returns recently published, which indicate great prosperity. 1000 w. R R Gaz—Sept. 10, 1897. No. 15278.

Discipline.

Report on Discipline of Committee at Annual Meeting of American Society of Railroad Superintendents. A discussion of the relations of employer and employed, with commendation of what is known as the "Fall Brook" system. 1300 w. Ry Rev—Sept. 25, 1897. No. 15597.

Euphrates.

Railway Scheme in the Euphrates Valley. The practicability of a shorter route to India, and the attempts made to obtain it. 900 w. Cons Repts—Sept., 1897. No. 15057 D.

French Railway.

Northern of France Railway. Information of interest of this most prosperous railway of Europe. 1400 w. Engng—Sept. 10, 1897. No. 15461 A.

Himalayan Railway.

The Darjeeling Himalayan Railway. Details of a unique mountain railway, worked entirely by adhesion. 1700 w. Engng—Sept. 17, 1897. No. 15556 A.

Improvements.

The Lake Front Improvements of the Illinois Central Railroad in Chicago. John Findley Wallace. Gives the history of the litigation between the railroad company and the city of Chicago, with illustrated description of the improvements. 5500 w. Pro Am Soc Civ Engs—Aug., 1897. No. 14995 F.

Journey Notes.

Notes of a Journey from Detroit to Duluth. Comments on the railroads traveled, and cities visited. 2800 w. Eng News—Sept. 2, 1897. No. 15015.

Lumber Preserving.

Tie and Lumber Preserving Plant at Somerville, Texas. Illustrated description of the plant, which comprises all the appliances essential for burnettizing and creosoting, and of the processes used. Other information is also given. 3000 w. Ry Rev—Sept. 11, 1897. No. 15293.

M. C. B. Rules.

The Revised M. C. B. Rules. George S. Hodgins. A discussion of the defects of the code. 2200 w. R R Car Jour—Sept., 1897. No. 15222.

Mounting Wheels.

Mounting Wheels and Gauge of Track. A. P. Gest. Read before the annual meeting of the Am. Soc. of R. R. Supts. at Nashville, Tenn. The correct gauge of car wheels, considered in its relation to the gauge of the track, and particularly with reference to frogs and guard rails. 3300 w. Ry Age—Sept. 24, 1897. No. 15571.

Railway Statistics.

The Railways of the United States in 1896. Statistics of railway construction and operation, taken from advance sheets of Poor's Manual for 1897. 1200 w. Eng News—Sept. 2, 1897. No. 15016.

Report.

Illinois Central Railroad Company. Extracts from the forty-seventh annual report of the directors to the stockholders, with editorial comment. 7000 w. Ry Age—Sept. 10, 1897. No. 15304.

The Atchison, Topeka, & Santa Fé Railway Company. Report for the fiscal year ending June 30, 1897, with editorial comment. 4500 w. Ry Age—Sept. 24, 1897. No. 15572.

Shops.

In the Shops. A statement of results of tests made by the Union Pacific railroad during Aug. to determine the relative value of coal, and a description of jacking up locomotives by compressed air in the Omaha shops of the same company. 900 w. Ry Age—Sept. 3, 1897. No. 15214.

In the Shops. Notes some recent improvements in equipment at the Rock Island shops in Chicago. Ill. 1500 w. Ry Age—Aug. 27, 1897. No. 14971.

Signs.

Standard Roadside and Station Signs—Cincinnati, New Orleans & Texas Pacific Railway. Drawings with particulars concerning the design and construction. 1000 w. R R Gaz—Sept. 10, 1897. No. 15280.

Track Work.

Best Method of Directing and Supervising the Work of Section Foremen. H. W. Church. Read before the Roadmasters' Convention. Discusses the details of the work, and what reports are necessary for the special information of the roadmaster. 2300 w. Ry Rev—Sept. 18, 1897. No. 15504.

Water Analysis.

Water Analysis on the Great Northern Railway. P. H. Conradson. Representative diagrams of results are given and explained, with directions for taking water samples. 1300 w. Ry Mas Mech—Sept., 1897. No. 15038.

STREET AND ELECTRIC RAILWAYS.

Accidents.

The Prevention of Accidents; The Best Method to Accomplish This End. H. S. Cooper. Read before the N. Y. State Convention at Niagara Falls. The answer found is the employment of good men, well cared for, well paid, well disciplined, &c. 3000 w. St Ry Rev—Sept. 15, 1897. No. 15485 C.

Accounts.

A Model Method of Supply Accounts. Gives method devised by Auditor Calderwood, of the Twin City Rapid Transit Company, Minneapolis. 1400 w. St Ry Rev—Sept. 15, 1897. No. 15475 C.

Berlin.

Berlin Elevated Railway. Brief illustrated description of the road, a portion of which will be an underground line. 350 w. St Ry Rev—Sept. 15, 1897. No. 15472 C.

The Electric Tramways of Berlin and Vicinity. Illustrated detailed description. 2000 w. Ry Wld—Sept., 1897. Serial. 1st part. No. 15316 A.

Boston Subway.

Opening of the Boston Subway for the West End Trolley Cars. H. W. Weiler. Brief description of the portion open to public travel. The route is indicated and the work described in detail. Ill. 3500 w. Elec Eng—Sept. 2, 1897. No. 15063.

The Boston Subway. J. E. Talbot. The purpose of the article is to describe in some detail the electrical and cognate features of the work. Ill. 3500 w. Elec Wld—Sept. 11, 1897. No. 15289.

Brooklyn Bridge.

The Accepted Plans for Electric Cars in the Brooklyn Bridge. Shows the course which it is proposed that the cars will take, the arrangement for loading and unloading the passengers, &c. Ill. 900 w. R R Gaz—Sept. 24, 1897. No. 15528.

Cable.

Cable Grip for Decauville Cars. (Grip à Machoires sur Waggonets Decauville.) Showing details of cable grip for small tipping cars used on the Decauville system of narrow gauge industrial railways. 1 plate. 1200 w. Le Génie Civil—July 10. 1897. No. 15162 D.

Charleston, S. C.

Electric Railways in Charleston. Illustrated detailed description of the new system. 2700 w. St Ry Jour—Sept., 1897. No. 15070 D.

The Charleston, S. C., City Railway Company. A description of its power-house and car barn. Ill. 2500 w. Elec Rev—Sept. 1, 1897. No. 15002.

Distribution.

The Three Wire and Other Systems of Distribution for Electric Railway Work. Extracts from the discussion of the paper on "Some Recent Developments in Electric Traction Appliances" read by A. K. Baylor before the (London) Inst. of Elec. Engs. relating to interesting and important features of American and English practice. 5500 w. St Ry Jour—Sept., 1897. No. 15074 D.

Dover.

The Dover Tramways. Illustrated description of recently constructed line now in operation. 1800 w. Elec Eng, Lond—Sept. 10, 1897. No. 15496 A.

Electrical Equipment.

See same title under Electrical Engineering, Power.

Electric Heaters.

The Present Status of Electric Heaters. A report of the principal changes made since last year. Ill. 1800 w. St Ry Jour—Sept., 1897. No. 15073 D.

Electric Railways.

A Decade of Electric Railway Development. William J. Clark. Extracts from a paper read before the Niagara Falls meeting of the New York State Street Railway Assn. Deals with the benefits that the general public have received through the use of electricity as a motive power, and shows that the accidents have been small as compared with steam roads. 1400 w. Elec Wld—Sept. 18, 1897. No. 15445.

Relationship Between Claim and Operating Departments of Electric Railways.—The Prevention of Accidents and Disposition of Claims. Richard W. Day. Read before the Pennsylvania Street Railway Assn. Discussion and suggestions relating to the subjects named. 2000 w. St Ry Rev—Sept. 15, 1897. No. 15479 C.

Employes.

How Can We Increase the Efficiency of Our Employes? W. W. Wheatley. Read before the N. Y. State Street-Railway Convention. Discusses the standard of service desirable for conductors, motormen or gripmen. 3500 w. St Ry Rev—Sept. 15, 1897. No. 15481 C.

English Railways.

Working Expenses of English Electric Railways. Information of the City and South London Electric Railway and the Liverpool Overhead Electric Railway. The other tramways do not issue records from which the expenses can be drawn. Tabulated statements are given. 750 w. Ry Wld—Sept., 1897. No. 15317 A.

Joints.

Casting Street Girder Joints Together. I. R. Newkirk. Read before the Foundrymen's Assn. The work is described and the claims for this kind of joint stated. 1500 w. Ir Age—Sept. 9, 1897. No. 15239.

Kansas City.

Central Avenue Station, Metropolitan Street Railway, Kansas City, Mo. Illustrated description of a good example of modern power-house construction. 2200 w. St Ry Rev—Sept. 15, 1897. No. 15471 C.

Electricity on the Metropolitan Street Railway in Kansas City, An account of the many improvements made, with illustrated description of the new central power house and its system of power distribution for the operation of electric and cable roads. 900 w. Elec Eng—Sept. 9, 1897. No. 15260.

Leeds.

Leeds Electric Tramways. Illustrated detailed description. 2400 w. Elec Rev, Lond—Aug. 27, 1897. Serial. 1st part. No. 15203 A.

Legislation.

Street Railway Legislation in Pennsylvania. Dallas Sanders. Read before the Pennsylvania Street Railway Assn. Reviews the legislation from omnibus days to the present, and records the improvements made. 3000 w. St Ry Rev—Sept. 15, 1897. No. 15480 C.

Measurements.

The Influence of Accurate Measurements upon Economic Operation. Caryl D. Haskins. Read before the N. Y. State Convention. Recommending the use of meters. 1200 w. St Ry Rev—Sept. 15, 1897. No. 15482 C.

Municipal Ownership.

Municipal and Private Ownership and Operation of Street Railways—A Study of Results and Possibilities. Edward E. Higgins. Concludes that the best solution of the problem is found in complete monopoly, private ownership and operation, perpetual franchises and a system of perpetual profit sharing with the municipality, joined to a remission of charges to the public if and whenever profits come to be sufficient for that purpose. 11500 w. St Ry Jour—Sept., 1897. No. 15075 D.

Municipal Ownership and Operation of Street Railways. H. H. Vreeland. Extracts from a paper presented at the N. Y. State Street Railway Assn.'s Convention. Discussion of the difficulties that would arise in purchasing back the franchises, and of various phases of the subject. 2400 w. Elec Wld—Sept. 18, 1897. No. 15444.

New Line.

The Central London Railway. Describes the western part of this road which runs from Marble Arch to Shepherd's Bush. Ill. 4000 w. Trans—Sept. 3, 1897. No. 15307 A.

Paris.

Electric Traction at Paris. From *La Nature*. Illustrated description of the installation and of the system adopted. 700 w. Sci Am Sup—Sept. 11, 1897. No. 15238.

Railway Plant.

The Cicero and Proviso Plant of the West Chicago Street Railroad Co, at Chicago, Ill. Illustrated description. The equipment consists of cross compound direct connected engines and dynamos and water tube boilers. 1000 w. Power—Sept., 1897. No. 15043.

Repair Shops.

Electric Street Railway Repair Shops. Robert Dunning. Read before the N. Y. State Convention. The writers of what have proved most practical for the proper maintenance of the repairs. 1200 w. St Ry Rev—Sept. 15, 1897. No. 15486 C.

San Francisco.

Electric Cars, Car Houses, and Car Repairs in San Francisco. S. L. Foster. A brief account of the cars and system of car maintenance practiced by the Market Street Railway Company, more particularly with reference to the electrical features. Ill. 4200 w. St Ry Jour—Sept., 1897. No. 15072 D.

Power House of the Market Street Railway, San Francisco. Illustrated detailed description of the largest system in the far west. 1400 w. St Ry Rev—Sept. 15, 1897. No. 15476 C.

Service.

Street Railroad Service Required by the Municipality. Deals principally with the service which city regulations prescribe, such as the regulation of the headway, the hours during which cars must run and the rate of speed. 2500 w. St Ry Rev—Sept. 15, 1897. No. 15474 C.

Shafts.

Shafts. E. Debus. The importance of this subject to the street railway engineer, with extracts from paper by G. W. Manuel, and from the discussion of the same. 2000 w. St Ry Rev—Sep. 15, 1897. No. 15477 C.

Steep Grades.

An Electric-Cable Railway. M. H. Bronsdon. Describes and illustrates a system suitable for cases where it is thought desirable or necessary to have a safety device, and one which is applicable to any grade regardless of the inclination. 800 w. St Ry Rev—Sept. 15, 1897. No. 15478 C.

Street Railroads.

Advantages of Up-to-date Street Railroad Service. Why the Rate of Fare Should not be Reduced. C. S. Rossiter. Read before the N. Y. State Convention at Niagara Falls. Discusses the need of electric street railways in cities, and the distance possible to travel for a single fare. 1300 w. St Ry Rev—Sept. 15, 1897. No. 15484 C.

Facts and Fancies Concerning Street Railroads. W. W. Cole. Read before the N. Y. State Convention at Niagara Falls. Discusses public and private ownership, and the attitude of leading magazines to this question. 2000 w. St Ry Rev—Sept. 15, 1897. No. 15483 C.

Suburban Railroad.

The Suburban Railroad of Chicago. Illustrated detailed description. Part of this system consists of sections of steam roads equipped for operation by electricity, and also used for street cars. 1400 w. St Ry Jour—Sept., 1897. No. 15071 D.

Third Rail.

The Crocker Safety Sectional Third Rail System. Describes the system and the test made in the yards of the American Ordnance Company at Bridgeport, Conn. Ill. 1000 w. Elec Eng—Sept. 23, 1897. No. 15518.

Track.

Cost of Track Construction. Specifications of eleven methods of construction with the estimates of cost, as prepared by John A. Beeler for the Denver Consolidated Tramway Co. 350 w. St Ry Jour—Sept. 15, 1897. No. 15473 C.

Traction.

Electric Traction on Elevated Roads. Leland L. Summers. Discusses principally the Sprague system. 1800 w. Elec Eng—Sept. 15, 1897. No. 15491.

See same title under Mechanical Engineering. Compressed Air.

Tramway.

A New System of Electric Traction for Tramways. (Nouveau Système de Traction Electrique pour Tramways.) An illustrated account of the Bersier System at Havre, with covered conduit and movable lid. 3000 w. Le Génie Civil—June 19, 1897. No. 15153 D.

Brussels Electric Tramways. Ernest Kilburn Scott. Information of special features in the construction and equipment, of routes, extensions, and matters of interest. Ill. 2200 w. Elec Rev, Lond—Sept. 17, 1897. No. 15579 A.

Electric Traction as Applied to Tramways. Frank Gaskell. The first of a series of articles describing and estimating the cost of the best systems of electric traction. 1500 w. Elec, Lond—Sept. 3, 1897. Serial. 1st part. No. 15306 A.

Electric Tramways. F. J. Warden Stevens. A review of the various forms of traction in use at the present time. Part first briefly considers horse, steam, gas or oil, and the cable systems, and commences the discussion of electric systems. 2200 w. Arch, Lond—Sept. 17, 1897. Serial. 1st part. No. 15566 A.

The Polyphase Electric Tramway at Lugano. (Tramway Electrique à Courants Polyphasés de Lugano.) An illustrated account of this recently constructed road. The alternating polyphase current is generated by water power over 7 miles from the town. 5000 w. Le Génie Civil—July 10, 1897. No. 15161 D.

Traveling Platform.

Proposed Traveling Sidewalk. (Projet de Plate-Forme Mobile.) An illustrated description of the elevated traveling sidewalk for the Paris Exposition of 1900, with plan and plate of details. 1 plate. 2500 w. Le Génie Civil—July 3, 1897. No. 15159 D.

Underground Trolley.

Construction Details of the Underground Trolley in New York City. Interesting description of the construction, with illustrations. 1300 w. Elec Wld—Sept. 18, 1897. No. 15443.

Electric Tramways with Underground Conductors. (Ueber Elektrische Bahnen mit Unterleitung.) Describing various existing systems of underground trolleys used in Germany, with sections of conduits and arrangement of switches, turnouts, etc. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—August 13, 1897. No. 15126 B.

The Underground Trolley in New York City. Brief illustrated description of the fine construction now being put in place. 700 w. Elec Wld—Aug. 28, 1897. No. 14964.

Wheels.

Street Car Wheels; Shall They Be Made Heavier? F. D. Russell. Read before the N. Y. State Convention. The changes needed because of change of power. Thinks, taking the 32-in. wheel for a standard, that 380 lbs. to 400 lbs. on 2¼-in. and 2½-in. tread is not too much for the present service. 1800 w. St Ry Rev—Sept. 15, 1897. No. 15487 C.

Zurich.

The Electric Tramways of Zurich. (Tramways Electriques de Zurich.) Describing this important and interesting plant, in which gas engines operated by producer gas furnish the motive power for the electric generators. 4000 w. Le Génie Civil—May 15, 1897. No. 15138 D.

BOOKS OF THE MONTH

The Standard Electrical Dictionary. A Popular Dictionary of Words, Terms, and Phrases Used in the Practice of Electrical Engineering. Second edition, revised and enlarged. By T. O'Conor Sloane. New York: Norman W. Henley & Co., 1897. Cloth, $3.00.

Dr. Sloane's electrical dictionary has been before the public for several years, and during that time it has found most acceptable use in many quarters. This, we believe, has been due, not only to the demand for an electrical dictionary in itself, but also to the fact that the work contains more than mere definitions, and really partakes of the nature of a compact electrical encyclopedia. Besides concise definitions of terms, processes, and apparatus, it often gives brief descriptions, with such illustrations as are necessary to complete the account. Synonyms of terms are also given, and a very full index dispenses with the need of cross-references.

The present edition contains an appendix of fifty pages, bringing the book well up to date,—a very necessary duty in view of the advances in electrical science since the work was originally issued,—and in the appendix will be found terms relating to radiography, wireless telegraphy, and other recent lines of investigation, together with the definitions of electrical units as determined at the international congress of 1893.

Practical Ice Making and Refrigerating. A Plain Common Sense Series of Papers on the Construction and Operation of Ice-making and Refrigerating Plants and Machinery. By Eugene T. Skinkle. Chicago: H. S. Rich & Co., 1897. Cloth, $1.50.

Eminently a practical book by a practical man, written in an entertaining, chatty way about a subject of continually-increasing importance. That It is somewhat rambling and discursive in style is probably due in part to the fact that the matter was originally published as a number of separate articles in the pages of *Ice and Refrigeration*, and perhaps in part also to the writer's desire to avoid formality; but there is much sound common sense in the book, and the author's evident earnestness is doubtless born of hard practical experience. The scientific engineer will have to look elsewhere for the mathematical computations involved in the problem of producing cold, but he may learn from this little book how far apart to space his pipes, and how to connect them to the best advantage; he will learn better than to use pipe which is galvanized inside, and will find some strong arguments against "oil injection" as a means of doing away with clearance. All may not agree with Mr. Skinkle's arguments and deductions, but he has made a very interesting series of practical talks about a subject which he has evidently studied in the master-school of experience.

The Journal of the Iron and Steel Institute, Vol. LI. Edited by Bennett H. Brough, secretary. E. & F. N. Spon, London, 1897.

The fifty-first volume of the *Journal of the Iron and Steel Institute* contains the usual collection of valuable papers from members in various parts of the world, together with the discussions and correspondence elicited. Mr. Head's paper on charging open-hearth furnaces by machinery is especially devoted to the Wellman electric open-hearth charging machine as used in the United States. Mr. Bertrand's paper on the Bertrand-Thiel open-hearth process is limited to an account of the practical working of the new combined process in the steel works at Kladno, in Bohemia. Two papers by Mr. Royston deal with "Malleable Cast Iron" and with "The Relation of Carbon to Iron at High Temperatures." Baron Jüptner von Jonstorff contributes two papers on "The Influence of Phosphorus on Cold-Shortness" and "The Determination of Hardening Carbon and Carbid Carbon." The American membership is represented by Dr. Henry M. Howe in a reply to the discussion of his previous paper on "The Hardening of Steel," and by Mr. Thos. D.

West on the "Utility and Economy of Central Blast Cupolas." A very comprehensive and thoroughly classified collection of notes on the iron and steel industries follows, together with the statistics for the previous year and a bibliography of the principal works relating to iron and steel published during the first half of 1897.

Le Four Electrique. By Henri Moissan. Paris: G. Steinheil, 1897.

M. Moissan's work with the electric furnace is well known to those who have followed the development of this important branch of electro-chemistry, he having been practically the first to use it systematically as a means of chemical investigation; and the record of his discoveries and researches has appeared in intermittent form in the shape of communications to the *Comptes Rendus* of the French Academy.

The present volume is practically a compendium of these previous papers, arranged and classified so as to form a very complete account of the methods of using the electric furnace in general, and of the results of M. Moissan's researches in particular.

After giving a description of the author's form of furnace and its operation, the behavior of the various refractory oxids is detailed, including their fusion, crystallization, and volatilization, with some especially interesting facts concerning the behavior of lime at the extraordinarily high temperatures attainable. This is followed by a chapter upon carbon, most of our recent knowledge of which element we owe to the electric furnace and to Moissan. A whole department of chemistry is devoted to the study of the carbon compounds, while but little, until very recently, has been known about carbon itself, considered as an element. The present work discusses it, in its three forms,—graphitic, amorphous, and crystalline,—and gives much space to the production of the latter in the form of artificial diamonds.

The electric furnace has also made possible the isolation in considerable quantities of numerous refractory metals, such as uranium, tungsten, and chromium, hitherto prepared only at great cost and in very small quantities. The production of the metallic carbids is another important function of the electric furnace, evidently destined to attain much commercial importance, and altogether the scope of this new metallurgical weapon it is at the present impossible to limit or foresee.

The book is at the same time valuable as a record of past researches and a guide to future work, and entitles its author to high rank as an investigator in modern science.

BOOKS RECEIVED.

Missouri Botanical Garden. Eighth Annual Report. Published by the board of trustees. St. Louis, Mo., 1897. Cloth.

Iron and Steel and Allied Industries in all Countries. James M. Swank, Washington. Government Printing Office, 1897. Paper.

The Money Question: A Handbook for the Times. Henry V. Poor. New York: H. V. & H. W. Poor, 1897. Paper, 50 cents.

Poor's Manual of Railroads. Thirtieth Annual Number. New York: H. V. & H. W. Poor, 1897. Cloth, $7.50.

New York State Reformatory. Twenty first Year Book. Elmira, 1897.

Journal of the Iron and Steel Institute, Vol. LI. Edited by Bennet H. Brough, secretary. London: E. & F. N. Spon; New York: Spon & Chamberlain, 1897. Cloth.

Some Fundamental Propositions Relating to the Design of Frameworks. Frank B. Cilley. Reprint from Technology Quarterly Vol. X. No. 2, June, 1897. Paper.

The Standard Electrical Dictionary. T. O'Conor Sloane. Second edition, revised and enlarged. New York: Norman W. Henley & Co., 1897. $3.00.

Current Transportation Topics, II. Recent Supreme Court Decisions and their Significance. Emory R. Johnson. Philadelphia, American Academy of Political and Social Science, 1897. Paper, 15 cents.

A Field Manual for Railroad Engineers. J. C. Nagle. New York: John Wiley & Sons; London: Chapman & Hall, Ltd., 1897. Morocco flap, $3.00.

Practical Ice Making and Refrigerating. Eugene T. Skinkle. Chicago: H. S. Rich & Co., 1897. Cloth, $1.50.

The Express Messenger and Other Tales of the Rail. Cy Warman. New York: Charles Scribner's Sons, 1897. Cloth, $1.25.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Edward P. Allis Co., Milwaukee, Wis., U. S. A.=Mining Catalogue "No. 36"; a handsome illustrated book of about 250 pages. Section 1 is devoted to engines, hoists, pumps, boilers, belting, and fixtures, 56 pages; section 2, to crushing, sizing, and concentrating machinery, 65 pages; section 3, to stamp, chlorination, and cyanid mills, 49 pages; section 4, to furnaces and machinery and appliances for smelting and refining works, 37 pages; section 5, to drills, air-compressors and receivers, 48 pages. There is an index to each section. The catalogue has the form of a series of excellent illustrations, with brief descriptive text accompanying each, and much collateral information as to cost of operations, specifications for typical plants, arrangement of machinery, and auxiliary appliances.

Gorton & Lidgerwood Co., New York City.=Small circular entitled "A Warm Discussion," giving general description, detailed dimensions, heating capacities, and prices of different styles of their side-feed boilers, burning hard or soft coal, for steam and hot-water heating.

Pancoast Ventilator Co., Philadelphia, Pa., U. S. A.=Price-list of ventilators manufactured by them, giving the capacity in square inches of each size, and results of comparative tests made by the Master Car-Builders' Association in the United States.

Gold Street-Car Heating Co., Chicago, Ill., and New York City.=Illustrated catalogue of electric heating apparatus, especially for street-cars, but adapted also to heating dwellings, steamers, etc.; describes also the "sealed jet system of hot-water circulation" for car-heating.

Cahall Sales Department, Pittsburg, Pa., U. S. A.=Leaflet giving in full the results of a test made by Geo. H. Barrus, of Boston, Mass., of a 200-h. p. Cahall water-tube boiler, showing remarkably high evaporative results and an excess of power over the guarantee.

Mason Electric Equipment Co., Chicago, Ill., U. S. A.=Leaflet stating claims and merits of their non-soldering line-hanger for electric railways.

Falls Rivet & Machine Co., Cuyahoga Falls, Ohio, U. S. A.=Illustrated leaflet of the Acme mechanical stoker, stating its advantages as to economy, efficiency, and convenience.

Porter Standard Motor Co., Lebanon, N. H., U. S. A.=Illustrated catalogue "No. 5," giving sizes, description, and prices of motors, batteries, and fans. Also leaflets of the "Ajax" battery motor and compound Fuller battery.

Northern Electrical Manufacturing Co., Madison, Wis., U. S. A.=Illustrated catalogue "No. 7," containing a chapter on electric driving and descriptions, with half-tone engravings of "Northern" dynamos and motors as applied to machine-shops, press rooms, launches, manufacturing establishments, and other classes of work.

The E. Horton & Son Co., Windsor Locks, Conn., U. S. A.=Illustrated descriptive catalogue, with price-lists, of the Horton lathe chucks and drill chucks as adapted to all kinds of machine work; also of repair parts and auxiliary tools. The pamphlet has 74 pages, and is indexed.

Jeanesville Iron Works Co., Jeanesville, Luzerne Co., Pa., U. S. A.=Handsome illustrated catalogue of 80 pages, in stiff covers, devoted to mine- and special-pumping machinery in great variety of patterns, styles, and adaptation to peculiar conditions of duty or power. The catalogue has convenient diagrams for ordering repair or duplicate parts, and an appendix of tables of water-pressures, friction-losses, and other useful information.

Government Printing Office, Washington, D. C., U. S. A.=Catalogues of United States public documents for July and August, 1897.

Michigan College of Mines, Houghton, Mich., U. S. A.=Prospectus for 1897-98, with plates and tables, giving the officers, course of instruction, degrees, and all other information regarding the college.

Union University, Schenectady, N. Y., U. S. A.=Special circular of important improvements recently inaugurated in the engineering school, involving changes in qualifications for admission, reorganization of curricula in general and sanitary engineering, and the final establishment of a course in electrical engineering.

Rochester Atheneum and Mechanics' Institute, Rochester, N. Y., U. S. A.=Circular of Information for 1897-98.

H. K. Porter & Co., Pittsburg, Pa., U. S. A.="Light Locomotives," eighth edition; an unusually fine, well-bound catalogue of over 200 pages, with clear small-scale illustrations (line engravings and half tones) and concisely-worded descriptive text and general specifications. The range of types is very large, comprising locomotives for all sorts of service, from 84,000-lb. passenger and freight engines to the smallest industrial or mine locomotive, and for steam, compressed-air, and electric power. The descriptive specifications are accompanied by a full code for ordering by telegraph. About 80 pages are given to tables and data which practically constitute a simple but excellent handbook of light-railway building and operation. They includes tables and memoranda of tractive force, of hauling capacity, of grades, curves, gage of track, elevation of rail, speed and loads, chapters on rails and special-service railroads, special system of haulage, estimates of cost, and comparisons of weights and measures. The catalogue is well indexed.

Boston Belting Company, Boston, New York, and Buffalo, U. S. A.=Card, describing advantages of Phoenix flange and joint packing,

R. D. Wood & Co., Philadelphia, Pa.=Elegantly printed and illustrated catalogue of hydraulic tools, cranes and machinery.

THE

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NATIONAL DIFFERENCES IN LABOR-HANDLING METHODS.

By Hiram S. Maxim.

THE Turkish metal-worker is able to produce some very remarkable results, as far as appearance is concerned, with the simplest of appliances. The primitive Turkish lathe is an exceedingly simple affair, but it requires a great deal more skill to execute a good piece of work on one of these lathes than to work any of the high-class tools that one finds in western Europe or America. A Turkish pistol may be of a highly ornate character, and, to the casual observer, may appear an excellent piece of work, but it will not bear close examination, as there is nothing approaching accuracy about it, and, of course, no two pistols are alike in any of their measurements. The Turk may be said to represent the extreme eastern system, where great skill in manipulation and very few tools are employed, and where everything goes for show and nothing for accuracy, while the Americans may be considered to represent the extreme west, where the tools are of the very highest character, and the skill necessary to operate them (not to make them) may be easily and quickly acquired. Nothing is sacrificed in an American pistol for ornamentation, but the accuracy of the work is something remarkable, and all pistols of the same class are exactly alike, and all their parts are interchangeable. All of the work on a Turkish pistol has to be executed by an old and experienced mechanician ; great skill in manipulation and taste in execution are a *sine qua non ;* but the elegant and accurate work that one finds in American pistols is executed for the most part by unskilled workers. The skill—or, as one may say, the brains—is in the accurate tools, or, rather, in the men who design and make them, and not in the simple operatives who attend to them.

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In Turkey the workshops are extremely small and the purchasers few, but in the United States, the population being very large and the demand for metal work very great, enormously large factories have grown up to meet the demand. It is because the country is large that it pays the manufacturer to put down a large plant and produce on a large scale. As already stated, the Turk represents the old, or extreme eastern, idea of Europe, while the American represents the new, or western, system, and Europe may be said to occupy intermediate grades. In the United States one may reckon on a very large demand for a standard article, and it pays the manufacturer to provide special tools and instruments for testing and measuring the work with a degree of nicety never attempted in Europe. Manufacture in the United States is specialised. One firm may confine itself to producing revolvers, and another to the production of sporting magazine rifles, while others make a specialty of lathe chucks, others of twist drills, others of high-speed engines of a certain type, others of gun-making machinery, etc. But in England one firm often undertakes a great variety of work. The consequence is that none of the factories are so well fitted for any special work as those of the United States.

Travelling eastward, we find smaller shops, fewer tools, and greater skill in manipulation. As in the United States it is a question of tools and a large production, so in the east of Europe it may be said to be a question of skill and small production. The English traveller invariably expresses surprise on entering a large American factory. He is not prepared for the cleanliness and order that prevail, while the American, in visiting many English shops, is simply amazed at the rusty and battered tools, and the dirt, disorder, and general sloth that are apparent. This, of course, is not true of the increasing number of thoroughly modern English shops.

When I first came to London, I wished to obtain a few tools, and, visiting a shop where they were sold, I was surprised at their rough and antiquated character. Upon asking them for something better, —something more like American tools,—the reply was: "Oh, these are real English tools, made in England, and everybody knows that English tools are the very best in the world." This was about fifteen years ago. No matter where I went, everyone was of the opinion that the only recommendation that a tool required was that it was made in England,—that it was real English, and genuine English make—none of your cheap and nasty German or American things.

When I desired to purchase some American hickory wheels to be used on light gun-carriages, the dealer refused to deliver them to me without tires. Upon asking why, he explained that formerly they had sold wheels without tires to anybody that came for them, but, as the carriage-smiths' and the wheel-makers' societies were closely affiliated, the smiths were provided with fine saws, with which they sawed off the tenons on the spokes before they set the tires. This gave American wheels a black eye for some years, until the trick was discovered.

It is, however, only in England that one finds an ignorant prejudice against American productions. In Germany, France, Austria, and Russia everyone is ready to admit that the Americans are ahead, and the Germans were, I think, the first to take advantage of the situation. In the United States it costs a large sum of money to design and perfect any particular machine, and very great care is always exercised before the machine is finally put upon the market. The English, as a rule, honestly believe themselves to be ahead of every other nation in every branch of manufacture, and it is only in recent years that a few of them have stumbled upon the truth that some really good things come from America. But, as a rule, they do not make blind copies of American work. They wish always to have a finger in the pie themselves.

A short time ago an American cable line was established in Brixton, a suburb of London. Upon first visiting Brixton, I failed completely to recognise the system, as each car was provided with a small and extremely ugly locomotive. Upon closer inspection, however, I found that the locomotive carried simply the clamping device. Upon asking the "driver," or the man at the clamp, the object of the apparatus, he said:

"Oh, this is the locomotive. This draws the car."

"Oh," I said, "how nice! Please explain it."

"Well, underground here is a wire rope; this ere thing goes down through this ere slot, and clamps the rope, and the rope pulls the locomotive, and the locomotive pulls the carriage, don't you see?"

"What is the object of the locomotive?"

"Why, to draw the car, of course."

"But why not put the clamp on the car, and dispense with the locomotive altogether?"

After he had thought the matter over a short time, I asked again:

"What is the use of the locomotive?"

His reply was: "I'll be hanged if I know."

Now, if this system had been introduced into a country like Germany, France, or Spain, the natives would have had sufficient respect and confidence in American engineers and systems to have put it up in the exact manner that it was imported; but, as the English engineers were used to a locomotive and wished to make some change in the American model, they added the "locomotive," which certainly looks very awkward, and is, without question, superfluous.

On the continent a different state of affairs exists and always has existed. There the highest opinion of things American prevails.

When the German government commenced to make rifles on the interchangeable plan, they imported a large quantity of gun-making tools from the United States, manufactured for the most part by Pratt & Whitney. The superiority of these tools was at once apparent. The result is that the Germans at the present moment are making machine tools of the American type in vast quantities, but, vast as the production is, the demand is still greater, and to-day the great firm of Ludw. Loewe & Co. has four times as many orders as it is able to fill, and is now putting up extensive works at a cost of £500,000. It was only a few years ago that anyone equipping a machine shop in Europe obtained the greater part of his metal-working machinery from England, but to-day the obsolete, awkward, and comparatively high-priced English tools have been completely driven out of the market by the German-made American tools. Not only have the Germans secured this market, but they are also sending their tools in large quantities to England. It is true, however, that these German tools are not quite up to American standards. The iron is not quite so good, and the accuracy is less. Nevertheless they are very much superior to the ordinary English tools, and Germany to-day is the most serious competitor that England has. This may not be very agreeable reading for Englishmen, but there is nothing to be gained by suppressing facts.

The German metal-workers, for the greater part, are sober and reliable ; they work very steadily from eleven to twelve hours a day, and are satisfied with wages considerably less than those which prevail in England.

The French have also taken advantage of American systems. A great many imitations of American tools are made in France, and many of them are up to the American standard.

While the United States and England employ a great number of horizontal milling machines using cutters with coarse teeth, which may be ground, the French use vertical milling machines as far as possible, and cutters with very fine teeth, which, as a rule, are never ground. They, however, have a very perfect apparatus for the rapid and cheap production of milling cutters of great accuracy. In France it is no uncommon thing to see a man running four planers, four lathes, or perhaps six milling machines. In fact, one man will often take charge of a whole roomful of machinery. Women are also employed, and run as many machines as they can attend to. There is absolutely no attempt at restricting the output of machines.

Many of the best French shops do not employ the same kind of lathe on ordinary work that they employ for tool-making. They have a special tool-maker's lathe, which, in its way, is a very remarkable machine, costing about £100 and provided with a great number of attachments. As a whole, the French tools are equal to any made in Europe, and in many of them a considerable degree of originality is displayed.

In Austria and Switzerland tools of the American type are coming into use, while nearly all the steam engines are constructed on the American Corliss system.

In Russia one finds the manufactures of all countries. A large dealer told me that formerly nearly everything came from England, "but," he said, "at the present time all the rough and coarse tools we make ourselves. Moderately good tools come from Germany; very fine instruments of precision, such as squares, scales, micrometers, lathe chucks, twist drills, etc., from America."

"But," I said, "do you not get anything from England?"

"Oh, yes: Stubb's files, Stubb's wire, and engraving tools."

An English expert, who has recently visited American factories, writes as follows:

> In the American shops, whatever work may be required, a special machine is made for the purpose, in order to turn out the work in the most expeditious and cheapest manner possible. With their system they obtain a machine and use it for one class of work continually, and the shops in general are more complete than ours, with up-to-date tools.
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> In the English shops, the manufacture of any one article is not sufficient to induce the manufacturer to use special machines for special work. In the English shops the generality of work is of a very varied nature, and the manufacturer who makes planing machines will also manufacture lathes, shaping machines, drilling machines, and various other tools, whereas in the American shops the manufacturers there apply themselves specially to the manufacture of one article as a specialty, and make it to the best of their ability for all it is worth. Until recently the English manufacturers have been working in the old methods of years gone by, with the same old tools which their forefathers used, but, owing to the competition brought about by improved American machinery coming into this market, they are now getting fresh methods and improving the shops very considerably. Unless the English manufacturers wake up to the fact that they should manufacture machinery of a better class and by improved methods, American tools will be coming into this market to an almost greater extent than heretofore.
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> The tools are better cared for on the other side, and the workmen there seem to take a greater pride in doing work to the best of their ability. It seems the object of the workman to become the most skilled mechanic that he can possibly be, whereas on this side a man is perfectly content in continuing in the same groove that he has been in for years past.

An American tool maker, who has traveled extensively in Europe and whose name is exceedingly well-known as a manufacturer of the very highest order of machinery, on being asked what he considered the true difference between English and American machine shops, wrote to me as follows:

> It is time England was waking up, for her machine-tool business is going away from her very fast. Germany and America (and even France in some respects) are getting ahead of her in a great majority of metal manufactures. The great obstacle that is in the way of success in her case is the *trade-unions.* So far we have been able to run our own business in our own way, this side, but in England the trade-unions have gone so far as to dictate to the manufacturer as to the number of apprentices he shall take, the amount of work a man shall do; in the latter case they dictate the size of chip the man shall take, and allow him to run but one machine. They even have, in some cases, insisted upon dictating who the superintendent should be. The result is, in most cases, less than one-half the work per man is done; in some cases, with our labour-saving machinery, even up to twenty times the work is done by an unskilled man whose wages are not more than England pays for a skilled workman. England, and nearly all European countries, to save themselves, are importing large quantities of American machinery and tools. The writer was asked to consider the matter of purchasing a plant in England for making a certain kind of machine, but experience has demonstrated that such work could be made for a less cost here and exported to England, for the reasons given above.
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> You understand, no doubt, what another great factor is which enables our manufacturers in metals to compete successfully with the world After we are satisfied that an article is saleable, we proceed to make a model and give it a trial. Sometimes several are made before a satisfactory test is produced. After it has proved satisfactory, we proceed to make special tools and machines to manufacture it with, and it is made by unskilled labor to some extent and at a cost much less than could be done in the old manner, and a better quality of work, and each part interchangeable.

From the above, as well as from my own experience, it will be seen that the English manufacturer has many things to contend with which are almost unknown in the United States. In fact, it may be said that the greatest bugbear in England, the labour question, is practically non-existent among the manufacturers of high class metal work in the eastern part of the United States. I do not believe that one per cent. of the highly-skilled mechanics in the great workshops of New England belong to any sort of a trade union. Trade unionism there, if it exists at all, is confined to the unskilled labourers, such as hod-carriers, navvies, dock labourers, stevedores, etc., while in England trade unionism pervades every class of labour, skilled and unskilled. The American manufacturer, in taking a contract, can depend upon his men. Before taking a contract, it is not an exception—in fact, I may say, it is the rule—to call around him a considerable number of his best mechanics. The drawings are examined, the manner of making the work, the tools that will be necessary, the probable cost, etc., are discussed; then the master decides on the price at which the contract may be taken.

The American workman commences work at seven o'clock in the morning, and every man is at his bench or his lathe promptly on the stroke of the bell. He works steadily until twelve o'clock; he then takes an hour for his dinner, and recommences work at one, continuing until six. On Saturday he works six hours, commencing at seven and leaving off at one.

In England it is supposed to be sufficient for the workman to pass the gate at six. He then dawdles along, spending from five to ten minutes in getting to his work. At eight o'clock he knocks off for half an hour for breakfast, and then works till one, when he has an hour for his dinner. He is supposed to commence work again at two o'clock, and to leave off at five, making nine and one-half hours a day and five and one half hours on Saturday—fifty-three hours per week. At the present moment, however, the workmen are striking for a forty-eight-hour week with fifty-three-hour pay.

The pay of the American metal-worker is about one-third more per hour than that of the English. Nevertheless a great variety of the better class of metal work can be produced in the United States at a considerably lower price than in England. It was not long ago that the Americans purchased steel in England, took it to the United States, paid 40 per cent. duty, made it into twist drills and fine tools, and sold them in England at a price considerably less than the cost of production in England.*

The labour question in England never reaches finality. Suppose, for the sake of argument, that the employers should grant a forty-eight-hour week with fifty-three-hour pay. There is not a single argument employed by the labour agitators to prove that an eight-hour day is preferable to a nine-hour day that could not be used with equal force to prove that seven hours is better than eight. Tranquility and contentment among the working-people is the state of affairs that the labour agitator does not like. He lives upon trouble and turmoil. If no actual grievance exists, he manufactures one so as to give at least some excuse for the support that he receives from his union.

It has always been the policy of the Engineers' Society to attack manufacturers singly, and then, when one has been subdued, to attack another. In the meantime, those who were at work supported those who were out on strike. But, now that the Employers' Federation has been formed, better things may be expected. Something of this kind was absolutely necessary, not only for the protection of the employer, but also for protecting the men themselves from their own folly. It is very evident that, if the engineering trade is to be kept in England, it is necessary that the employer should have the full and unhampered services of his employees, and the only way to accomplish this is to weaken the power of the professional agitator.

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*This is true now, with the important exception that very many Americans make their own steel and therefore do not have to import it.

SHIP-BUILDING AS A PRODUCTIVE INDUSTRY IN GREAT BRITAIN.

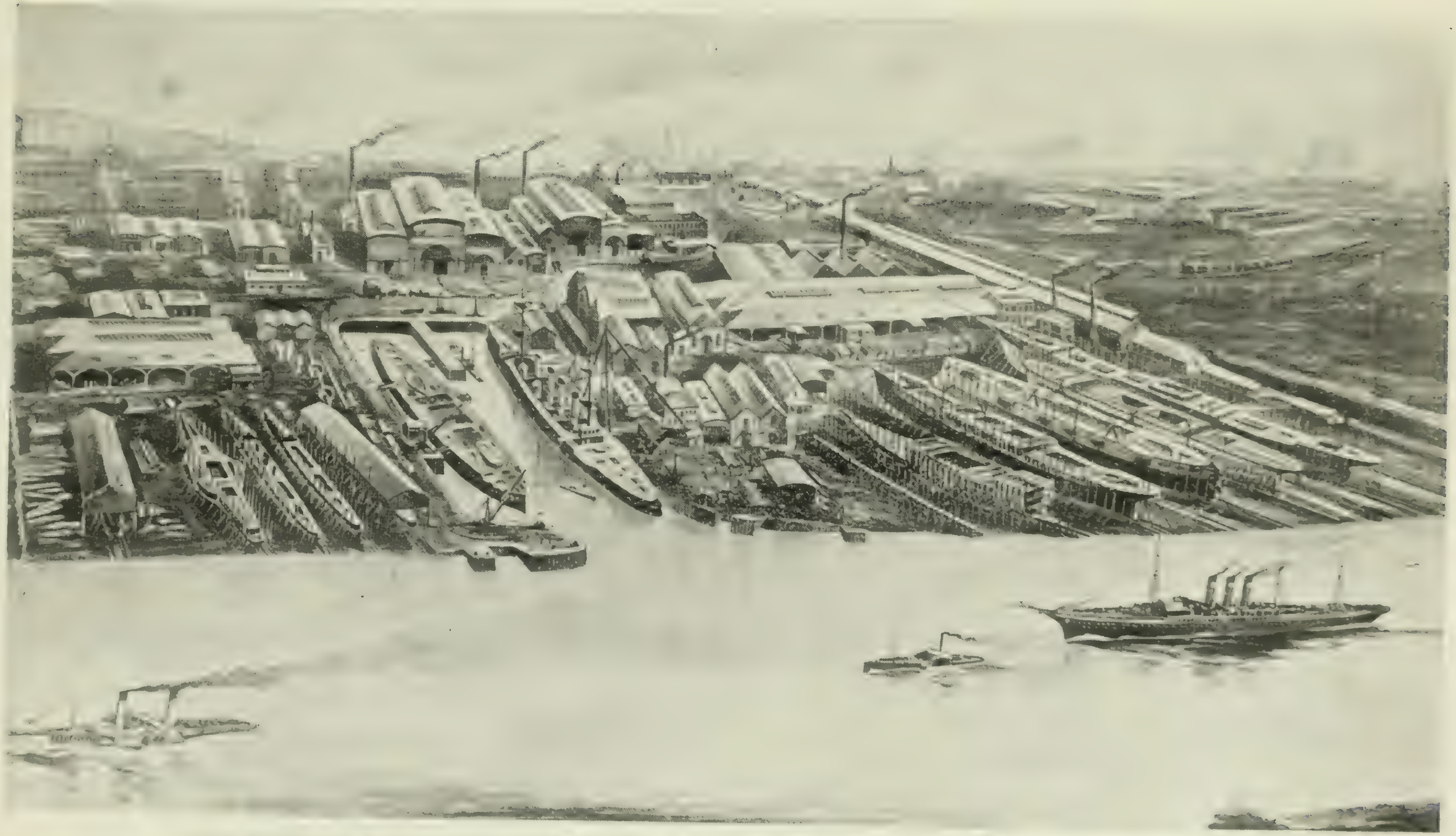
By James McKechnie.

I. THE ECONOMIC RELATIONS OF ITS ENORMOUS GROWTH.

NO more profitable subject of contemplation for the ship-builder is conceivable than the full significance of Britain's maritime industries, especially in view of the progress of other countries. True, he has little time for such study: enough perhaps is provided for every-day occupation by the insatiable demands of the shipowner for another fraction of a knot, or fifty tons more of deadweight capacity than had an immediately preceding ship, without additional cost. And yet the economic difficulties with which the manager of any industrial concern is beset, owing to the artfulness of the trade-union leader, forces one to give heed to the wider practical questions associated with manufacturers. It was doubtless this consideration which prompted the editorial appeal to me to enter into an analysis of the recognised importance of the marine industries to Great Britain, of the methods of maintaining the supremacy enjoyed, and of the significance of the efforts of other nations to secure some part, if not a great part, of the trade monopolized.

The time is not inopportune, and the subject has fascinations for the ship-builder, in which term I include for convenience the marine engineer. To some it may involve an issue too vital, but, as a rule, the very frequency of those labour troubles which underlie the whole question of the migration of industries and the prophecies of national disaster has engendered more or less of philosophic calm. Each hair-breadth escape deepens the hunter's love for adventure, while at the same time quickening his wits. And thus the ship-builder, while he does not court trouble, meets it nevertheless with peaceful reflection rather than with unreasoning panic. I do not take the view that self-interest is inoperative: but it must be recognized by all who care to see below the surface that the profit realisable is so meagre that many find themselves asking the question whether the game is worth the candle.

Let me take first the consideration which will appeal most readily to the average reader—the significance of the industry to the labouring class. It is certainly the most direct result because the first realised; any lessening in the demand for new shipping means at once idleness for the artizan. By a careful computation, which, although it might

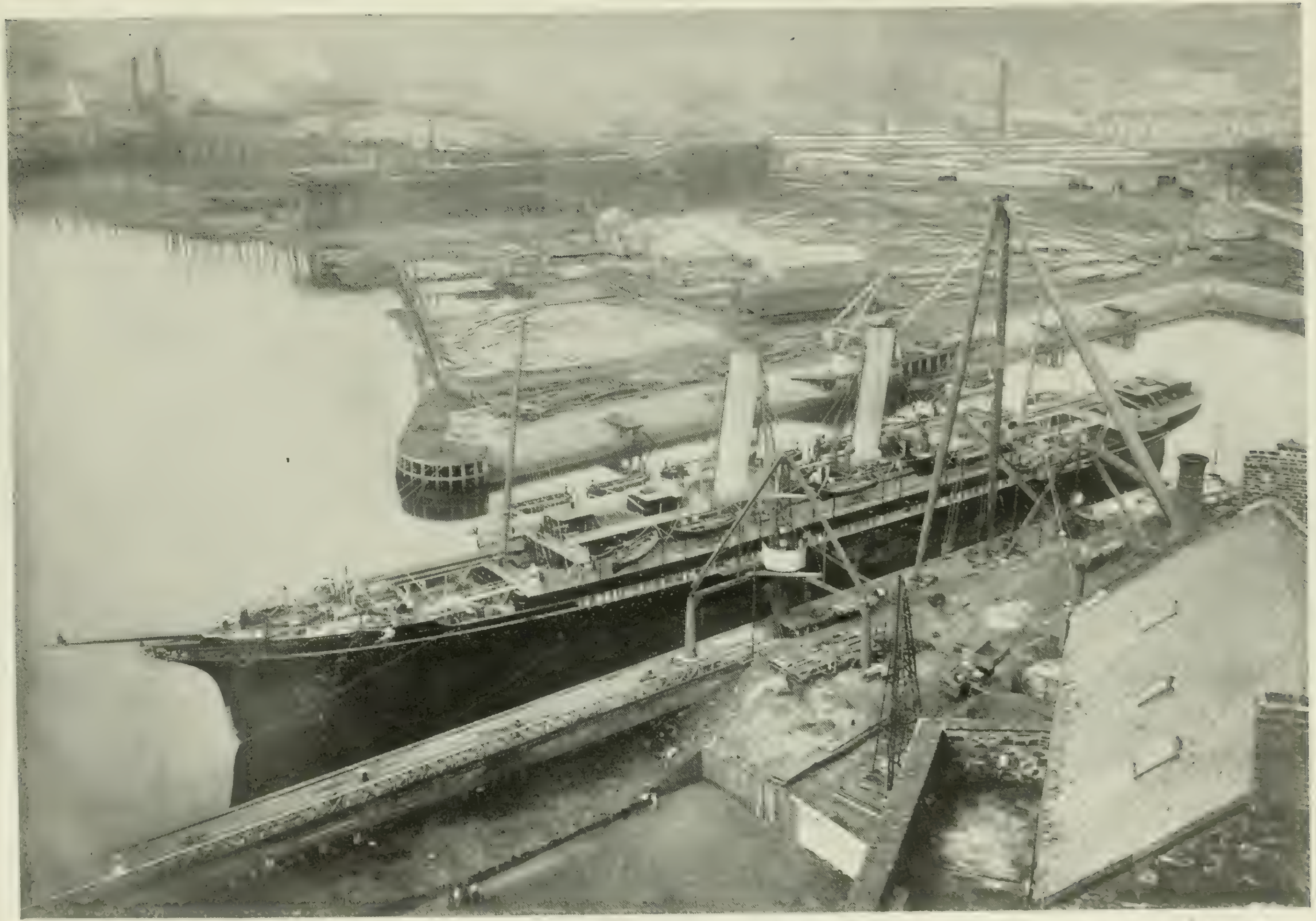


THE SHIPYARD AND ENGINE WORKS OF THE CLYDEBANK ENGINEERING & SHIPBUILDING CO., LTD.

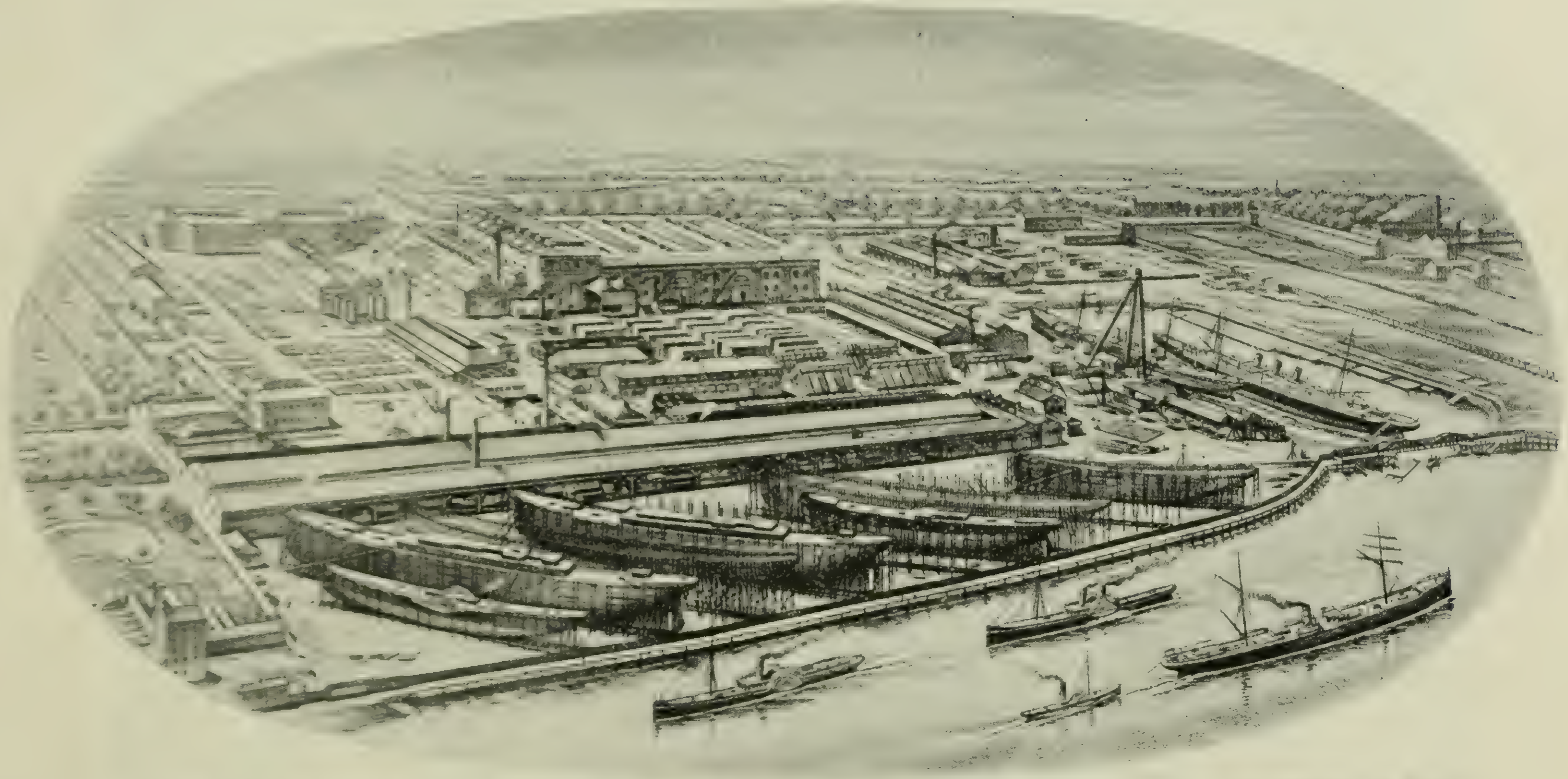
shock our old taskmaster, Euclid, is nevertheless sufficiently accurate for our purpose, I find that in an average year the ship-builders, including marine engineers of course, distribute in wages between eleven and twelve millions sterling. The cost of labour on an ordinary type of cargo steamer is about 34 per cent. of the total value of the vessel; on passenger steamers, with their superbly fitted and decorated saloon, the ratio is much higher; on marine engines the labour-cost ranges from 30 to 40 per cent. It is easy, then, to arrive at the labour-value of a given production. I have included the work done in the royal dockyards, where, owing to the admirable system of accounting, it is easy to ascertain the amount distributed for labour, now about two million sterling per annum; but the total value of work now done in private yards for British and foreign navies exceeds as a rule by quite 50 per cent. that completed in the royal establishments. But this does not by any means exhaust labour's share in a year's shipbuilding.

Vessels aggregating 1,200,000 tons gross register—about the yearly average from all yards in Britain—require much steel, and this metal is not delivered in the building yard without a considerable labour-charge. It is interesting to note the labour-cost of winning the coal for each successive stage, of mining the iron ore, of melting it into pig iron, and finally of making the finished metal and rolling it into the angles and bars and plates which go to complete the anatomy of a modern ship. In few of these processes has it been found possible to supersede manual labour to the extent that it has been superseded in other branches of industry, and yet the price has been greatly reduced, although the rate of wages has not been lessened. Pig iron is a typical case. In 1877 the selling price was fifty-five shillings; to day, by increasing the size of the blast furnace and introducing mechanical appliances in connection with charging, it has been possible to reduce it to forty-five. This suggestion of labour's inviolable right to equal, if not higher, remuneration, while the value of the finished product is reduced, is, however, by the way.

It is possible to arrive at a very close approximation of the labour-cost of a ton of steel. The depth at which the minerals are found, the metallic quality of the ore, and the quantity required to make the finished product, necessarily affect the result; but I take normal or medium cases. About fifty-five per cent. of the price of coal goes to labour in some form or other, and of that of iron ore about sixty per cent.; softer ores are perhaps more cheaply mined, but generally a larger quantity must be used in the blast furnace. It may be taken that, on an average, two tons of coal, and two and one-quarter tons of ore or ironstone, are needed for each ton of pig iron.



BIRD'S-EYE VIEW OF MESSRS. W. DENNY & BRO.'S YARD, DUMBARTON, WITH S.S. SCOT IN THE WET DOCK.



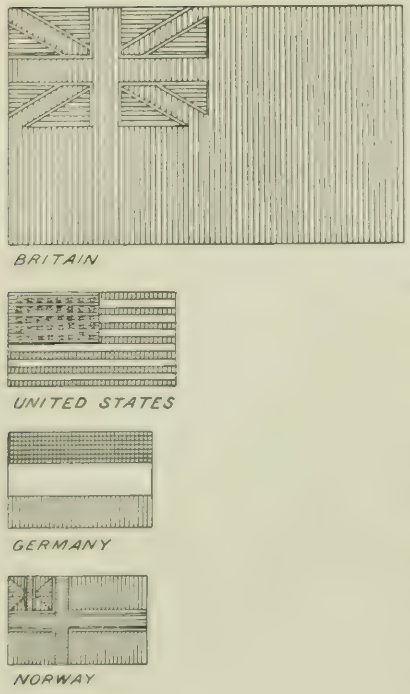
THE WORKS OF THE FAIRFIELD SHIPBUILDING & ENGINEERING COMPANY, LIMITED, GOVAN, GLASGOW, IN 1891.

The conversion process alone involves a labour-cost equal to a fourth of the ordinary selling-price of the pig iron. This raw material and one or two other ingredients, whose cost of production need not be analysed, go forward to the steel furnace, where fifteen per cent. of the ultimate selling-price of the steel is directly absorbed by labour. If these various contributions to labour be summed up, it will be found that almost exactly one-half—rather more than less—of the price of the finished steel goes to labour.

If, then, the labour involved in the production of the steel used in the ships built in a year be taken into consideration, the eleven or twelve millions sterling disbursed by the ship-builder amounts to about sixteen millions sterling, and in this is not included the contribution made, in name of transit, to the wages bill of the railway or steamship companies, or the cost of the many other materials used in building. I have made allowance also for the increasing amount of iron ore imported, the labour-cost of which is not disbursed in Britain. Last year Britain imported about five and one-half million tons, of which four and three-quarter million tons came from Spain. Yet, without the ship-building industry, our blast furnace-men and steel makers would not have the privilege of converting this into pure metal.

The influence of ship-building on England's shipping supremacy is a further important item on the credit side of the ledger. Her insular position would have made that shipping a necessity in any case, and her large deposits of metalliferous ore and coal ensured the establishment sooner or later of a merchant fleet of her own, and therefore of a naval force also. But it must be admitted that the initiative came from the marine constructor, and at the appropriate moment for the expansion of industries and of empire. The United States at the beginning of the century, with their wooden-built clippers, appeared to hold an unassailable position, and retained it long after iron ships were introduced. But, as soon as the system of compound engines was perfected and the coal consumption was reduced from 7 to 3 and even 2¾ pounds per h. p. per hour, the American clippers were beaten, if not in average speed, certainly in economy. That was Britain's flood tide; her mineral wealth enabled her to take it. Prestige was soon earned by the skill of the ship-builder and engineer, although few will deny England's debt to France, perhaps also to America, for some lessons and examples in the form of ships. The period of conflict and of bloodshed on the continent assisted, while the civil war in the United States set back the hands of the clock there.

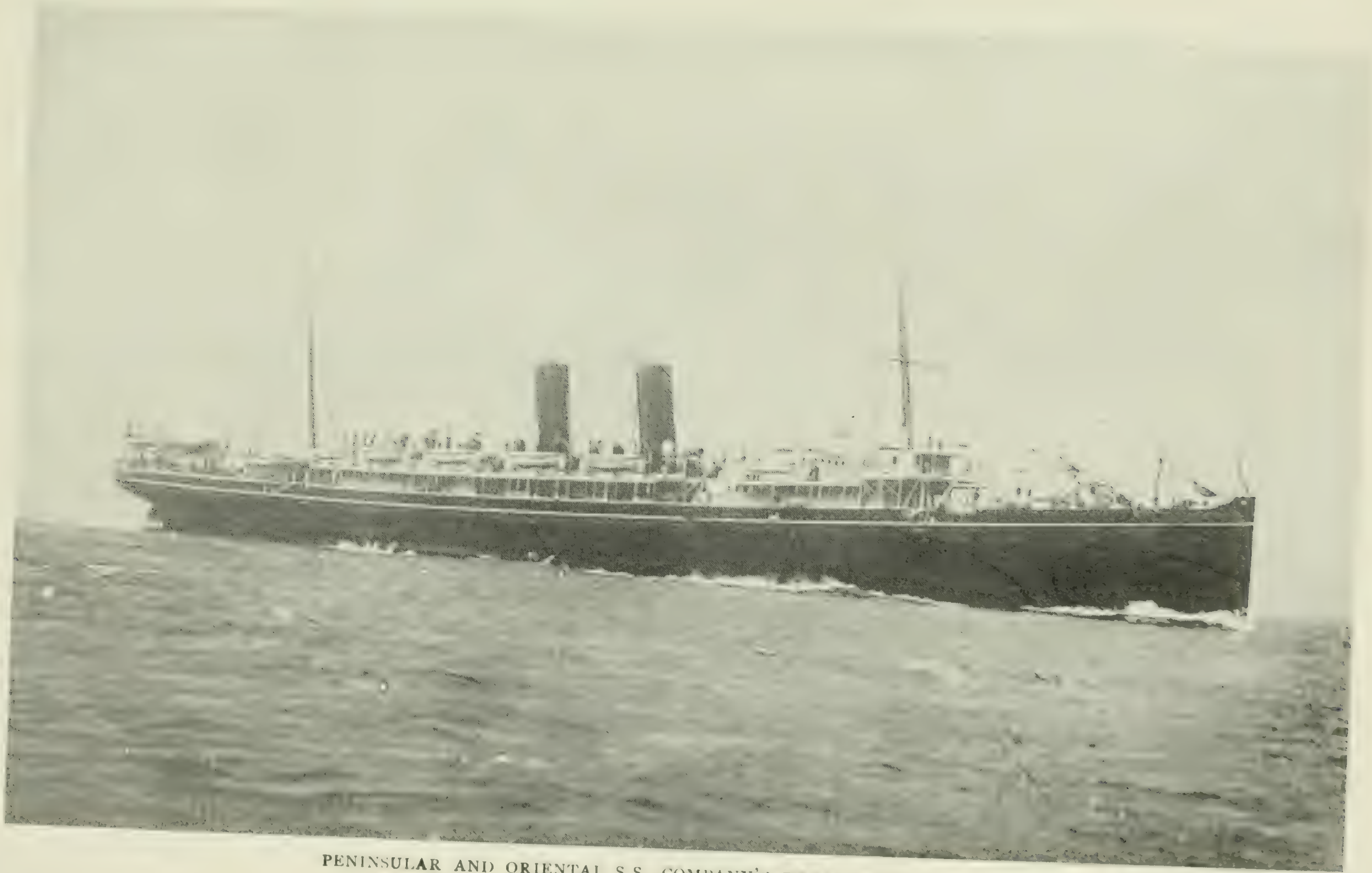
I am not concerned for the moment with the future, and its certain and vigorous contest by the awakened countries; it is enough



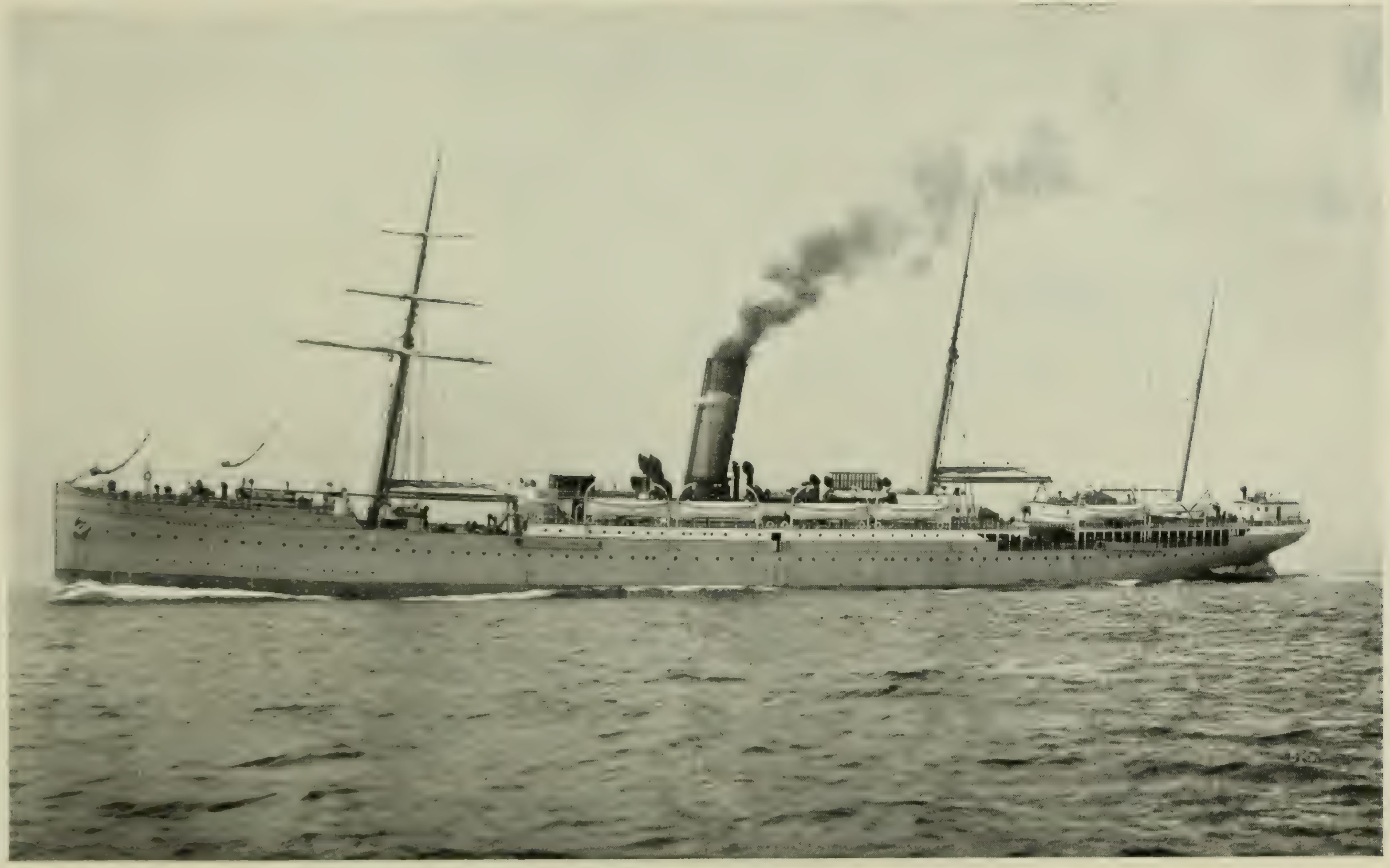
FLAGS ARRANGED ACCORDING TO MERCHANT TONNAGE OWNED BY PRINCIPAL NATIONS.

here to suggest that, having got the start, having established a great fame, it will be the more difficult, although by no means impossible as some think, to dislodge Great Britain. Evidence of her supremacy in maritime affairs is easily established. Her merchant fleet, according to Lloyds' almost infallible record, is nearly 13,250,000 tons, and, although the average size is 600 tons, there are many vessels of more than 6,000 tons. Psychological considerations—love of adventure, tendency to a nomadic life, etc.—partly explain this great floating population and wealth; but there can be no question of the encouragement offered to early British ship-owners by the low cost of ship-building, and, once established, the advantage was gained. The series of flags reproduced on this page conveys an idea of the relative proportions of the fleets of various nations, according to Lloyds. For every 100 tons of ships possessed by Britain the United States have only 16.6 tons, Germany has 14.6, Norway 12.5, France 8.45, Italy 5.85, Spain 5.28, Russia 3.9, Sweden 3.66, and Holland 3.33; other countries need not be indicated. It is worth stating, further, that Britain owns more than one-half of the sea-going merchant ships in the world. This preponderance could be maintained through all these years only by the influence of superior and economical ship-building, none the less robust because developed without artificial aid.

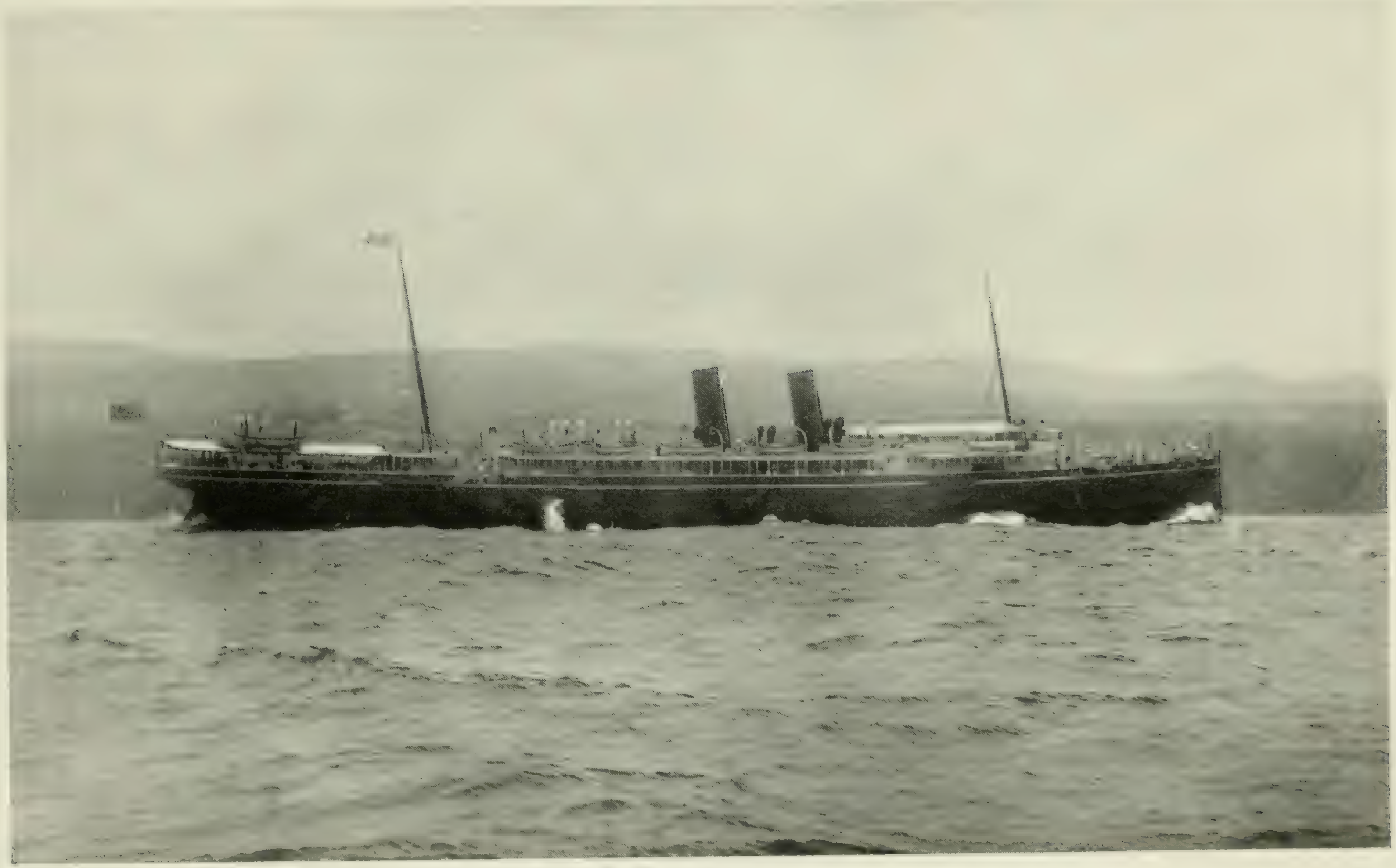
The work done by these vessels is a great source of national wealth. Thus the freightage on nearly three-fifths of the world's commerce is money-gain to Britain. A diagrammatic representation of this is interesting. The tonnage of vessels entering and clearing the ports of several nations is shown on page 382 by a series of squares,



PENINSULAR AND ORIENTAL S.S. COMPANY'S ROYAL MAIL S.S. INDIA.
Built by Caird & Co., Ltd., Greenock.



ROYAL MAIL S.S. DUNVEGAN CASTLE, OF THE CASTLE MAIL PACKETS CO., LTD.
Built by the Fairfield Shipbuilding & Engineering Co., Ltd.



S.S. TALISMAN.

Built by A. & J. Inglis, Pointhouse Shipyard, Glasgow.
By permission of J. Adamson & Son, Rothesay.

and within each is shown the proportion of British tonnage, and that of native tonnage, the remainder being that of other nations. The data are taken from the latest Board of Trade returns. Thus, the square for the United States shows that the tonnage frequenting her ports is nearly 33,750,000 tons, excluding the lake ships. Of this she provides 3,680,588 tons, while Britain supplies 17,500,000 tons, or 52.3 per cent. Even if the lake tonnage were included, America's proportion of her own trade would be only 23 per cent. In each square the black part represents Britain's share, the shaded part the share of the country in question, and the white part that of other countries. While much of the merchandise represented by the black section is foreign merchandise, there is strong reason for the saying that trade follows the flag. These British ships are splendid advertisers of her commerce, as well as of her ship-building, while at the same time earning wealth in freightage. Again, it is the possession of this fleet, as well as the influence of the Bank of England, which makes Britain the great exchange emporium of the world. Seventy million pounds' worth of goods are so transhipped per annum; twenty years ago the value was only forty millions. The diagrammatic representation shows that 47 per cent. of the shipping frequenting French ports is British-owned, notwithstanding shipping bounties to French ships. Of the German over-sea-carrying 38 per cent. is done by vessels carrying the Union Jack, meaning 13,333,000 tons of British ships in German ports in a year. In Russia the proportion is 54 per cent.: in Holland 50.9 per cent.: and in several other countries about half. Sweden and Norway are the most nearly self-supporting, 80.4

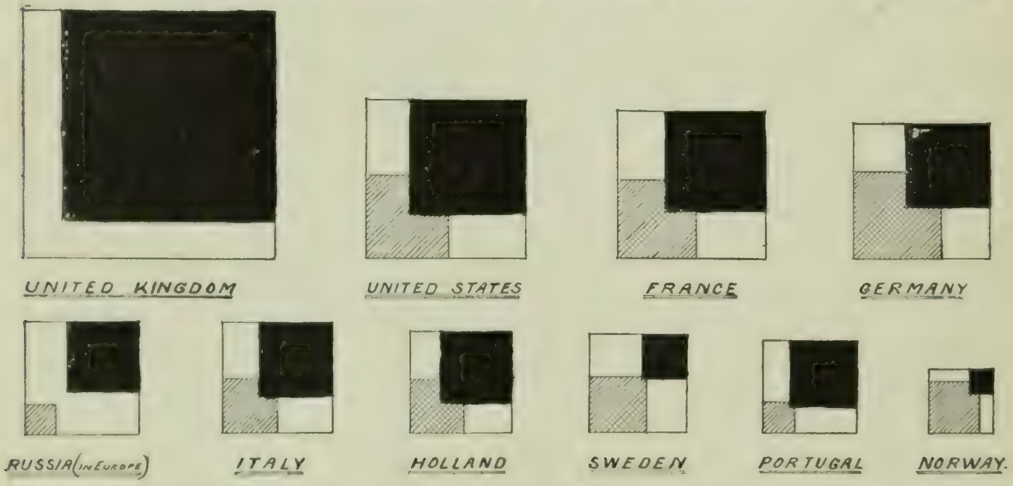
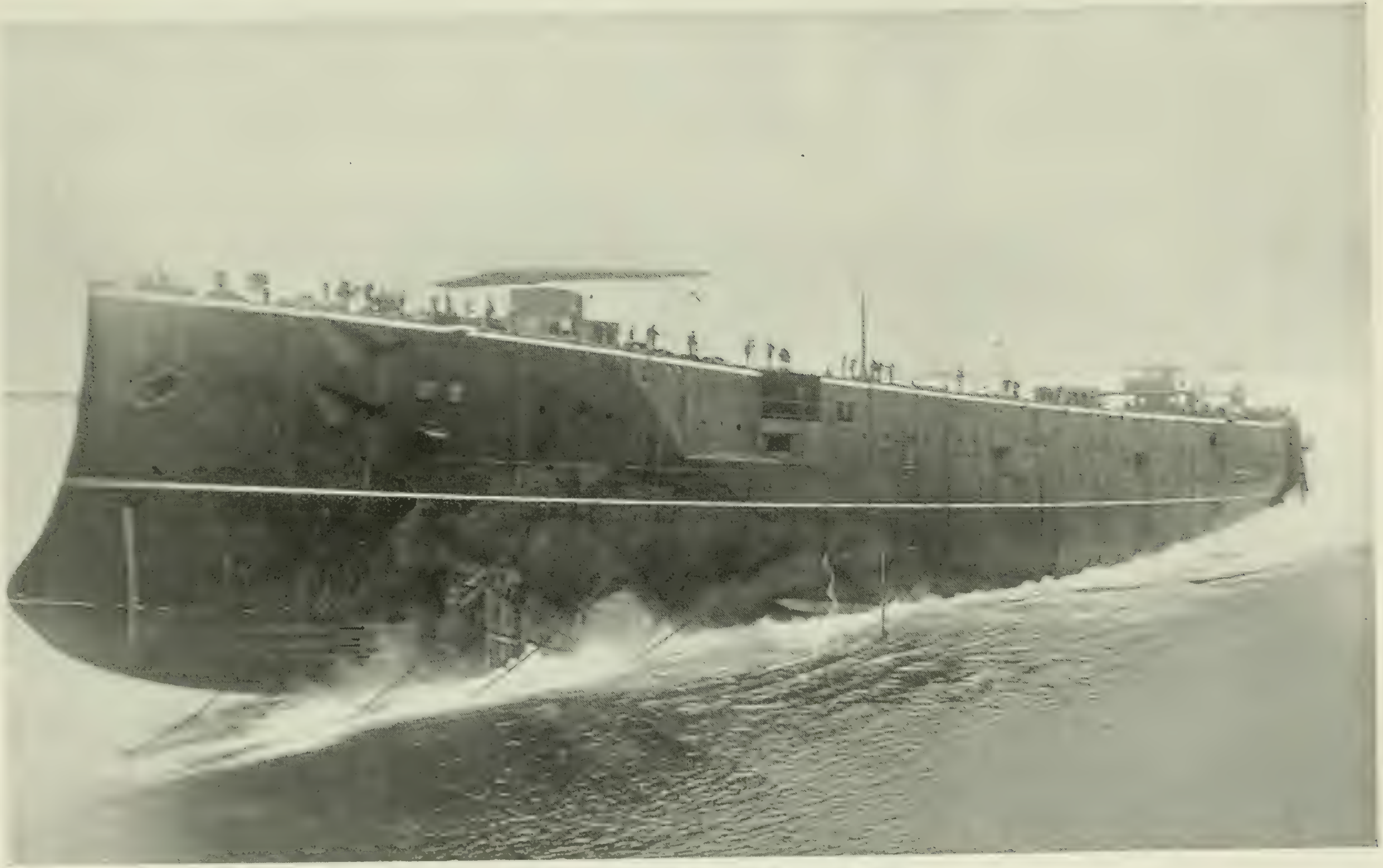


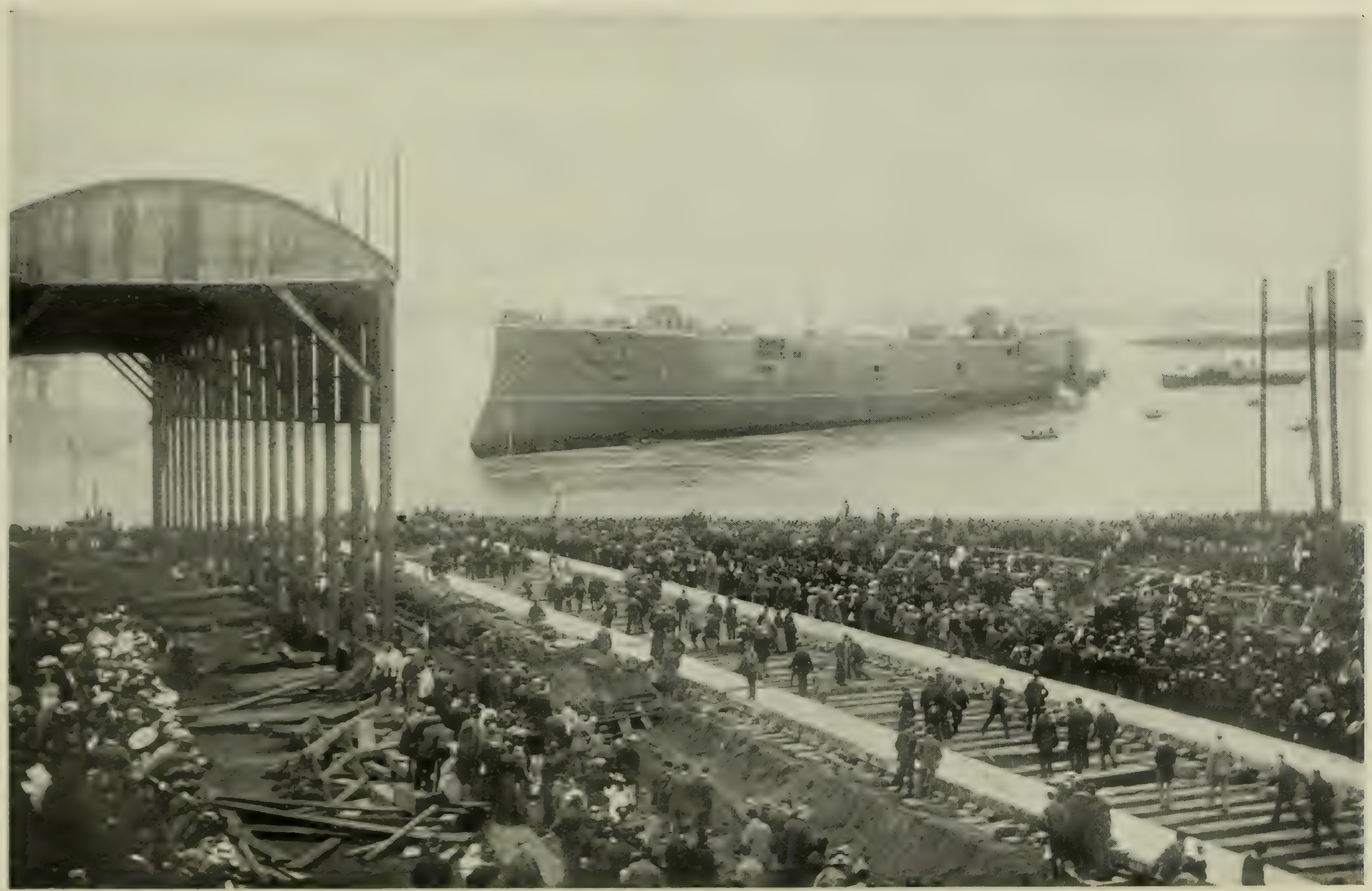
DIAGRAM SHOWING THE TONNAGE ENTERING THE HARBOURS OF VARIOUS NATIONS.

The black area in each indicates British tonnage, the shaded area, tonnage owned in the country, and the white part the tonnage of other nations. Thus, in the United States square, black is British, shaded American, and white foreign.



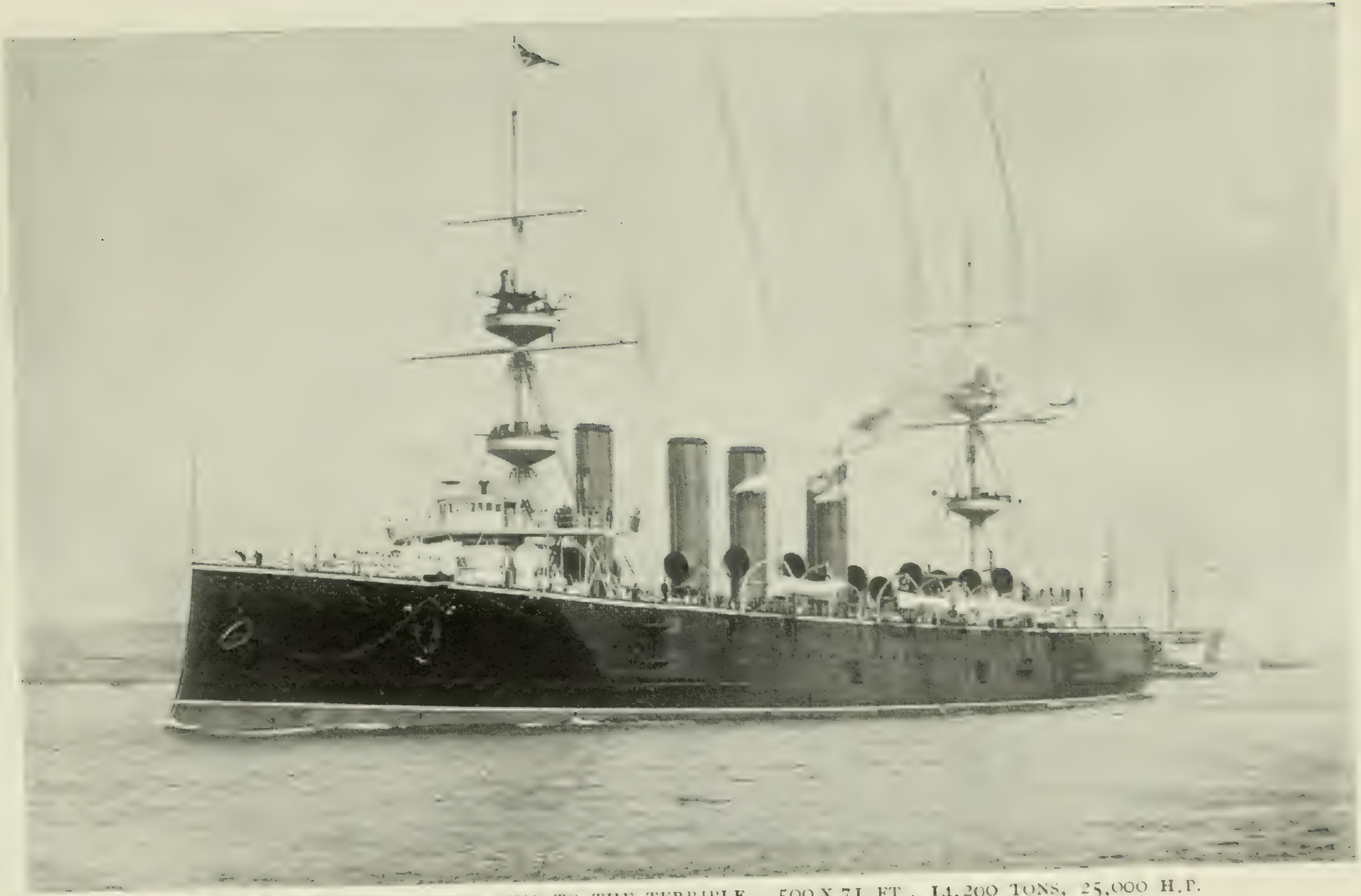
H.M.S. POWERFUL TAKING THE WATER.

Copyright by Arthar Hollis, Barrow-in-Furness.



H.M.S. POWERFUL SAFELY AFLOAT; SHOWING THE SHIPWAYS.

Copyright by Arthur Hollis, Barrow-in-Furness.

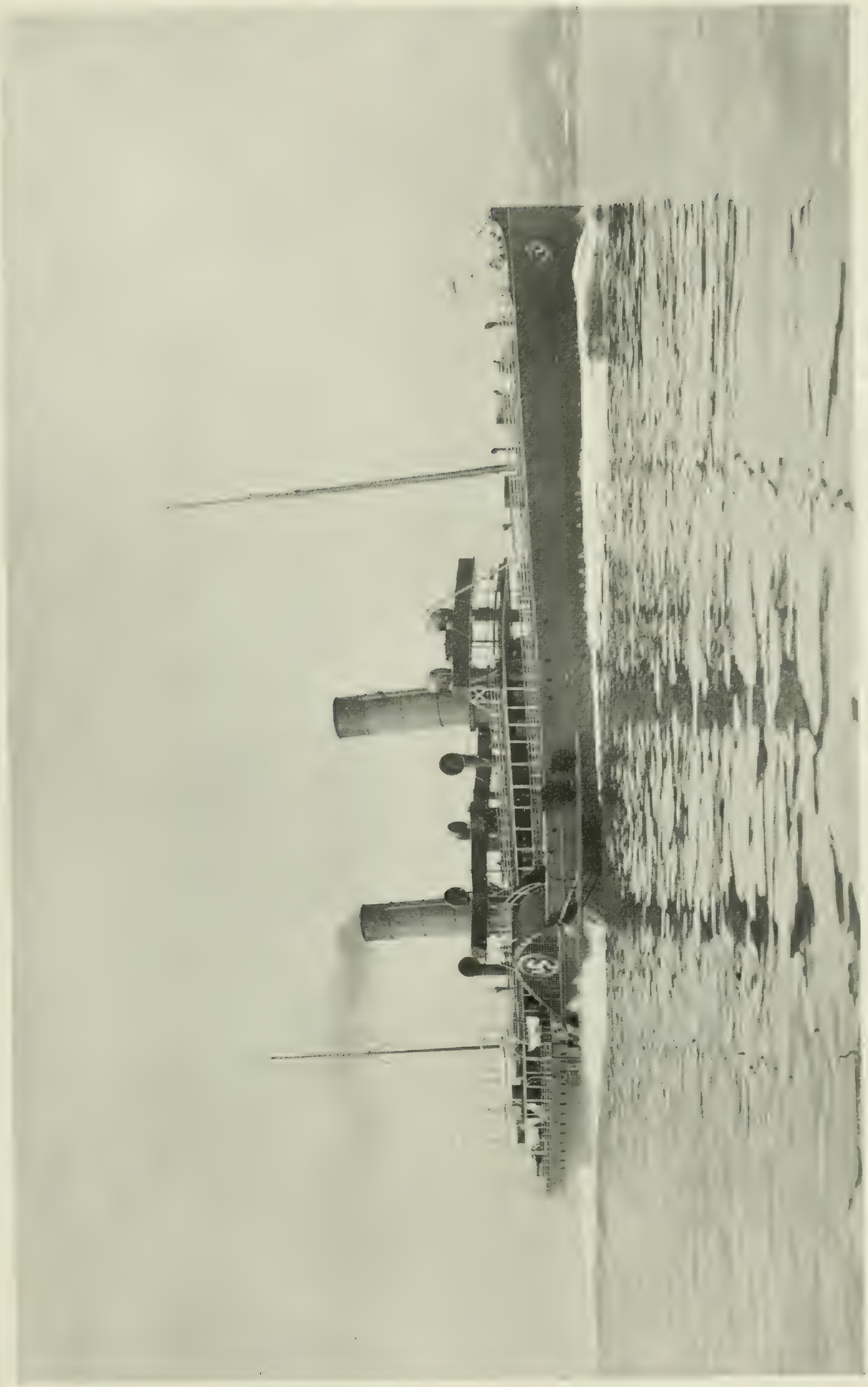


H.M.S. POWERFUL, SISTER SHIP TO THE TERRIBLE. 500 X 71 FT., 14,200 TONS, 25,000 H.P.
Built by Vickers, Sons & Co., Ltd., Naval Construction Works, Barrow-in-Furness.
By permission of Stephen Cribb, Southsea.

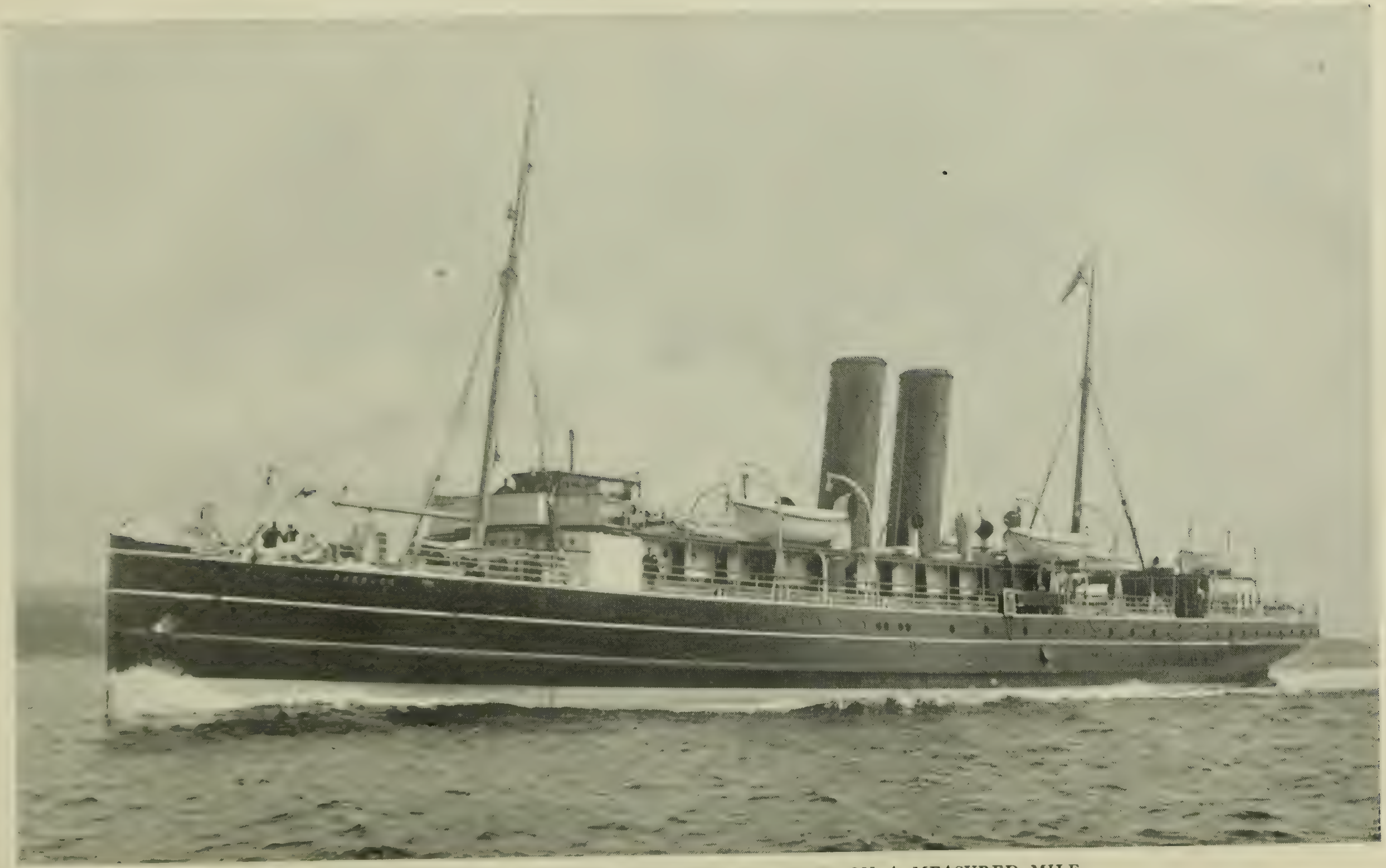
and 86 per cent. of the ships being of their own nationality. Truly, the old viking is still to the fore, but until recent years was content to buy Britain's old tonnage. This record is a satisfactory one for Britain, and suggests that, if Britain's naval fleet were assailed in war and vanquished, more than the inhabitants of the insular kingdom would have difficulty in getting their food-supplies from over the sea. But this idea may be dismissed; her naval fleet is equal to its task, and, even if it were not so, it could soon be made more powerful, for there is in private yards capacity for building sixteen battleships within three years,—even in two years at a pinch,—as well as twenty-five cruisers, and a complete swarm of those wasps of warfare,—torpedo-boat destroyers. It is the fleet which has the quickest recuperative power that will ultimately triumph.

I have used the word "native" in referring to foreign-owned tonnage, but the term must be qualified. In eight years builders in Britain have constructed for foreign owners vessels aggregating nearly 1,750,000 tons,—an average of 200,000 tons per annum. This includes war-ships; but, if we consider only merchantmen, we find that the average is now more than 150,000 tons, while ten years ago it was about 80,000 tons, and forty years ago only 25,000 tons. An examination of the fleets of foreign powers, indeed, shows the preponderance of British-built tonnage. Including only vessels of 1,000 tons and upwards, I find that in the present German mercantile fleet there are 310 British-built ships; in that of France, 234; Norway, 217; Spain, 171; Italy, 153; Holland and Belgium, 135; Austro-Hungary, 93; Russia, 84; Sweden, 74; Denmark, 65; United States, 23. The greater proportion of this foreign tonnage comes from the Clyde district, whose repute is undoubtedly high: but in this respect, I fancy, it does not by any means so far out-distance the other districts as formerly. This is in some measure due to the wider distribution of Clyde-trained men. I might recall the names of many of my old colleagues at Fairfield and Clydebank now occupying positions of high responsibility in many of the other ship-building centres on the north-east coast of England and at Belfast, but it opens up too great a vista. Moreover, the standard will of necessity improve.

There is no doubt that Clyde practice is an influence, although it might be said of the north-east coast in this connection that the Jews have no dealings with the Samaritans. I shrink from raising any jealous ire. And yet the industry is not of great antiquity on the Clyde. I do not know that any managing partner of to-day can claim that he occupies the establishment of his grandfather, although several firms have lately been celebrating their jubilees,—McMillan



PADDLE STEAMER EMPRESS QUEEN—A TYPE OF AN IMPORTANT CLASS.
Built by The Fairfield Shipbuilding & Engineering Co., Ltd., Govan, 1897.



TWIN SCREW S.S. ROEBUCK STEAMING 20 KNOTS ON A MEASURED MILE.

The Roebuck and Reindeer are sister ships, 280 x 34.4 x 23.6 feet, built for the Great Western Railway Co.'s service to the Channel Islands by Vickers, Sons & Co., Ltd., Barrow-in-Furness.

By permission of J. Adamson & Son, Rothesay.

and Denny's of Dumbarton, Inglis of Glasgow, and others. All the old ship-building firms within the harbor of Glasgow have been crushed westward by the harbor authorities, excepting Inglis: but, after all, Patrick and Govan, where many yards exist, are but continuations of Glasgow, north and south of the Clyde. One might as well say that Fifth avenue is not in New York because its name was not Broadway.

Of the yards existing, Thomson's, now known as the Clydebank Engineering & Shipbuilding Co. Ltd., is the largest in area. It has 75 acres, affording plenty of elbow-room, and employs between 6,500 and 7,000 men. Fairfield is not far behind. Between them they share the honors of the nursery for ship-builders and engineers, and one could not well wish for better tutors than the men who have from time to time presided over the departments. Sir William Pearce was a smart ship-builder and a good man of business. John Elder was an ideal engineer, a good systematic mechanic. Dr. A. C. Kirk had inventive genius, and was a fit successor to Elder. Mr. Bryce Douglas had engineering experience, courage, energy, and great administrative capacity—very essential characteristics. Of these one can speak freely; they are no longer with us. The many Clydebank men now in positions of responsibility readily attribute much of their professional success to the business and professional abilities of their chiefs.

The same fitters were employed on almost all the big Atlantic greyhounds, irrespective of the yard where they were constructed. During the period of competition between the two firms in connection with the Atlantic service, Sir William Pearce was in the full vigor of his professional life, and his methods of meeting the Clydebank ships soon after they were laid down were almost sensational. I do not intend to enter into the narrative, pleasantly reminiscent as it is. The great successes of the Aurania, Alaska, America, Umbria, Etruria, New York, Paris, and, still later, of the Campania and Lucania, are well known: but, as a record of progress, I put down here the length, tonnage, power, speed, and approximate cost of some of the vessels.

Date.	Name.	Length b. p.	Tonnage.	Power.	Speed.	Approximate Cost.
1881	Alaska . . .	500 ft.	6,932	10,500	18	£250,000
1884	America . .	432 ft.	6,500	7,354	18	£190,000
1884	Etruria . . .	500 ft.	7,718	14,321	20	£300,000
1888	Paris	527 ft. 6 in.	10,499	20,000	21–8	£330,000
1893	Campania.	600 ft.	12,500	28,000	22	£520,000

Of course, each boat was more palatial than its predecessor, and carried a bigger population,—that is the right word, for the later ships are complete microcosms,—and this partly explains in some way the increased cost, although the great power required for high speed was the principal factor. Curiously enough, only Messrs. Harland & Wolff entered into this contest, and even their ships were few in number. I might also mention the City of Rome, built by the late William John, at Barrow, and the Columbia, built for the Hamburg-American line, at Laird's of Birkenhead. In other speed contests Fairfield and Clydebank have had the opposition of the Dennys of Dumbarton, particularly in twin-screw and paddle steamers for the channel; of Messrs. Laird of Birkenhead; of the Naval Construction Works at Barrow-in-Furness; and of Messrs. Inglis of Glasgow; while the builders of seventeen-knot boats are now very numerous. The estuary of the Clyde has always been noted for its fleet of smart passenger boats, and almost every firm has contributed. The quiet season in journalism is not infrequently enlivened by correspondence and reminiscence concerning the old craft.

The results in the past were no doubt eminently creditable; but the difficulties of adding to nineteen knots increase in a vexatious ratio, so that the meed of praise now due should be the greater. It is no longer a case of rule of thumb; that belonged to an era when speed penalties were not exacted, and when remedies were rough and ready. In one case one and a half knots were added to speed by planing a bit off the wooden paddle floats, enabling the engines to run away easily; another firm, learning the secret, applied the same simple remedy in the case of their next unsuccessful steamer, but it did not cure the deficiency of boiler power, which was the real cause. The irony of it lay in the fact that the floats, being iron, had to be chipped in position, and then had to be destroyed as too small! Now-a-days such methods are too expensive to be relied upon with equanimity, and the position held by the industry in Britain is due to the assurance which past results give to prospective clients of the realization of their requirements. That is why I insist on the point here. Experience does much in this respect; experiment is a grand help, but not a substitute. I recall the case of a twin-screw steamer assumed by some to be of impossible dimensions, but cheerfully undertaken by Messrs. Denny, as a result of tank experiments. Again, there was required within the past two years a paddle steamer for the channel. So onerous were the conditions that several firms considered a twin-screw steamer preferable, and experiment confirmed one or two firms that refused to tender. One firm accepted the order, and had to regret it.

This substitution of the twin screw for the paddle engine in many cases is really a typical case of the evolution of types, and may be briefly indicated. The beam engine, still beloved in the United States, has long been discarded, although Messrs. Inglis have had, within comparatively recent years, several successes for China. In some respects it is still unexampled, especially in the absence of vibration; but compound diagonal or even triple-expansion engines are preferred. We have reached almost the limit with paddle wheels 23 feet in diameter having floats 9 feet long. The Empress Queen, (page 387) Fairfield's latest triumph, could not be docked in Glasgow, owing to her great beam over the paddle boxes, and yet the biggest screw steamers, mercantile and naval, have been accommodated. The advantage of the paddle propulsion where draught is limited is self-evident; but I have heard of cases of the slip being 26 and even 30 per cent., which is out of all reason. Willans, with his fast-running electric engine, opened a way to the torpedo-boat and channel-steamship builder. By increasing the revolving speed of the propellers, it was possible to reduce their diameter, ensuring the necessary complete submersion with a light draught. Thornycroft and Yarrow did good service, and now, in vessels of the "Roebuck" type (page 388), the engines run up to 164 revolutions, giving a piston speed of 1,066 feet per minute, while the loss by slip is only 13 per cent. at 20¼ knots. Many such twin-screw steamers have been built in recent years, at Clydebank, Denny's, Barrow, Laird's, Fairfield, and Earle's of Hull. The twin-screw steamer has superseded the paddle boat in the Newhaven & Dieppe trade, and in the Holyhead & Kingstown run; it is entering the Dover & Calais service, and is supreme in the Channel Island service; and now, when a new service is spoken of between Liverpool and the Isle of Man, the Roebuck type is preferred to the Empress-Queen class.

Every firm is ready to make experiments, and considerable ingenuity is displayed; but, as a rule, each successive ship of a class is evolved from the experience gained with its predecessor, for, although conditions may alter slightly, the fundamental principle is constant. Success may be qualified; but, after all, more can be learned from an analysis of failure than from success. Messrs. Denny, as is now well known, have an experimental tank for running models and deducing results, after the system first introduced by the late Mr. Froude; and thus they are perhaps able to accumulate data more rapidly than the builder whose observation is confined to the performances of real ships instead of paraffin models. Their tank costs them in salaries £2,000 a year; but the paraffin wax is used time and again. The advantage is in its non-porosity, the ease with which it is planed, the immunity from alteration of form as compared with wood, which absorbs so much water, and, finally, the fact that there is no temptation to "hoard" useless models. The certainty with which the final result can be achieved is probably sufficient compensation for the outlay; but it stands to reason that, although the process is by no means mechanical, consisting in the application of known laws, there is just a tendency to weaken the imagination. However, there can be no question of its great utility, and, since all builders are careful students of the work of others, there is reason to believe that the models evolved in their tank have had an influence on naval architecture throughout Britain and in European countries generally. But even a tank is of no utility without the experience hardly won, and herein consists Britain's strength.

I have said much about these high-speed vessels, because they are the show-window wares of the British ship-builder. The world too often reverses the Biblical test about faithfulness over small things; the ruler over many things is he who hath done first the mighty deeds. Thus the many other types of ships follow the few high-speed craft. There is the long-distance passenger liner, where high speed is contingent on fuel economy, owing to the distance between coaling stations. The "man in the street" does not so readily appraise the effort involved in keeping down the power and the coal consumption of a Pacific steamer, an Orient, a P. & O., or a South African liner. She may do her 380 sea miles per day, whereas the Atlantic greyhound does 520 or 550 sea miles, but the general reader does not understand readily that the magnificent speed is got at four times the expense in coal and other items in the engine room. And yet these 380-mile ships carry more paying cargo, and are not only the mainstay of the ship-building industry, but in very truth the

> Swift shuttles of an empire's loom.

SUPREMACY IN THE IRON MARKETS OF THE WORLD.

By J. Stephen Jeans.

II.—SOME ELEMENTARY CONDITIONS OF SUPREMACY.

IN a previous article we have considered more particularly the relations of Europe to the United States. We may now suit, ably consider the relations of European countries to each other-as rivals and competitors. But we could not say much in relation to the circumstances of the iron trade that has not already been set down or suggested in the report drawn up two years ago by the delegation which inquired into the cost of the conditions of labour in the iron industry of continental Europe—a delegation composed of seven workmen and seven employer representatives, which, as secretary to the British Iron Trade Association, it fell to my duty to organize, and which I served as honorary secretary.

The report of this delegation admits again and again that labour is more steady and reliable on the continent than in England. Strikes, it is stated, are almost unknown in Germany, and the workmen do not make any broken time worth speaking of. On this point the report points one or two obvious lessons. Strikes being very rare, "it is obvious that the steady course of industry in any country has a tendency to give stability and permanence to its operations which could not be expected from other conditions"—that is to say, from a constant liability to suspensions of work by reason of differences between employers and employed. Again, the delegation were greatly struck "with the sobriety, steadiness, and readiness to act upon instructions," of the workmen on the continent, and hence the natural reflection that "the workman who is regularly and steadily engaged at work is not only earning better wages for himself, but is in a better position to do good work, while the effect of such a state of matters on the employer is that he gets the maximum production out of his plant—no heats being lost through broken time, etc." But it must not be overlooked that, although it may not be "stipulated in the bond," the continental workmen have a great amount of consideration extended to them as a reward for this docility and steadiness of conduct. They are assisted to "acquire houses and gardens on reasonable terms, whether as tenants or as owners." Then the majority of the workmen on the continent, at least in the countries visited, are assisted in the matter of State pension and accident-assurance funds to an extent that is hardly known in England. The State imposes burdens upon German manufacturers from which British or American employers would be likely to shrink with dismay. The delegation found that at one large establishment in the Fatherland the State burdens of all kinds amounted to about £50,000 a year, and at two others, in the same locality, the kindred burdens were £40,000 and £35,000 a year, respectively. These are portentous figures,—almost the income of some grand duchies,—and yet the manufacturers have no remedy, since it is the law of the land. For accident assurance alone the iron and steel industries of Germany have to provide an annual payment of £310,000, or an average of about 10 shillings per worker insured, to which average it has rapidly risen from 3½ marks per head in 1886. We are not surprised, therefore, to find it added that other serious increase of cost has led to several proposals being made and considered, with a view to either diminishing the amount of the indemnities and pensions, or so altering the law itself as to reduce its pressure on the industrial works of the country. But the employers in Germany appear to regard these heavy payments as being to a large extent an insurance of themselves against strikes.

And the obvious lesson taught by the facts ascertained at the German industrial works is the inutility of labour organizations—or, at any rate, of strikes—for the purpose of securing a reasonably high rate of wages. The delegation speaks as if trade unions were non-existent in Germany and Belgium, but, whether common or rare, they have evidently very little influence; yet the rate of wages paid to unskilled labour in Westphalia is stated to be as high as in Great Britain. The labourers in German steel works did not secure their 3s. 6d. to 4s. per day by the force of agitation and physical pressure. No more, for the matter of that, did the labourers in Victoria or Queensland, Idaho or California. The truth is that the rate of wages is a function of the economic conditions prevailing in a particular place or country at a particular time, and the wages are higher in Germany than in Belgium because Germany happens to have better competitive circumstances—at any rate in its iron industry, which, for a number of years, has been exceedingly prosperous. Our trade unions would do well to lay to heart and profit by the facts as to this matter which their colleagues on the British iron trade delegation have disclosed. There is no peril that environs the British manufacturer of which he stands in more dread, or to which he is more constantly exposed, than a strike, and the average employer would esteem himself lucky indeed if he enjoyed the immunities that appear to be the recognized heritage of his continental rival, from this point of view. The enormous loss, inconvenience, and distress caused by strikes in Great Britain tend to become more and more accentuated and intolerable as industrial operations tend to assume larger proportions. Several of these industrial wars have broken out of late years that have lasted for months, and have caused direct losses that are estimated at many millions. But it is the constant fear of a repetition of these troubles that is the most serious restraining factor in British industry. It is not to be marvelled at if, in view of this constantly-suspended sword of Damocles, manufacturers lose heart, and determine, as many have done of late years, to throw up a game that seems to be so risky and profitless.

One of the most important questions raised by the facts just stated is that of how far the English manufacturers are likely to be affected favourably or unfavorably by the discovery that wages in Germany are much more nearly on all fours with those in Great Britain than they were supposed to be. It might be hoped that low wages on the continent would, by and by, be raised to our own level, and that, as continental workmen became more and more *exigeant* in their demands, their range of wages would become more or less identical with that of their English brethren. But this view cannot be maintained in face of the ascertained fact that wages do not much affect the situation,—at least so far as Germany is concerned,—and that other causes have a more powerful influence in enabling competitors to secure a firm footing in markets which, judged by every consideration of interest and reciprocity, should be exclusively British, or nearly so.

Another essential difference in the conditions of carrying on the commercial arrangements of continental industries as compared with British is founded on the existence on the continent of the system of protection. The customs duties levied on imports into Germany, for example, protect the German manufacturer from competition in his own market, so that he can always depend upon securing, within the limits thereby prescribed, a satisfactory price from his home customers. This result, as is proved by the recent experience of the United States, would not necessarily follow without a certain amount of organization, but the Germans are adepts in the art of accommodating themselves to circumstances, and they consequently have a whole legion of syndicates designed to regulate production and price in the different branches of trade and industry. The evil of overproduction is thereby kept in check, and prices are well under control. The home business, in short, is made so profitable that manufacturers can afford, if necessary, to lose on export orders, which they often do, for the double purpose of building up a trade, and keeping their manufacturing establishments and their workmen fully employed. There is much method in this arrangement. With production on a large scale, standing charges are kept down, and the cost of manufacture is lessened, while the workmen, having full and regular wages, are not likely to be so difficult to handle as they would be if—as often happens in England—they were employed only to the extent of one-half or two-thirds of the full time. Of course, in so far as Germany, or any other country, sells in neutral markets at less than cost, it is not fair competition. It could be effectively met only by the adoption elsewhere of a similar economic system, which, however, cannot be looked for in England, wedded as she is to free trade, whatever consequences that system may involve.

The British iron trade delegation appears to have arrived at the conclusion that the greatest factor in favour of the foreign producer is the much lower cost of transport, and they express the opinion that, "if English manufacturers enjoyed the same railway rates and royalties as those on the continent, foreign competition could be defied in neutral markets." The natural inference is that it is the British railway companies that have been the most persistent and successful instruments in strangling British trade, and that they have in this been aided and abetted by the owners of the soil, whose charges for royalty are greatly higher than those paid in any continental country. This is not a new discovery. What is new is the knowledge that it was a much more potent cause of the ills from which we suffer than either the lower wages paid in continental countries, or any other contributory cause. The report quotes figures to show that, while the long distance rates in Great Britain run from a penny to a penny halfpenny per ton per mile, similar traffic is carried on over similar distances in Belgium and Germany for a halfpenny or less. In other words, the English rates are, in many cases, about three times the rates charged in competing countries. This, of course, makes an enormous difference to English trades and manufactures—a difference that may be better understood when we add that the total income of British railways from mineral traffic is about nineteen millions sterling a year, or very nearly as much as the whole realized value of British exports in iron and steel. It would be absurd to say that the railway companies of Great Britain could at once, or at any future time, be expected to carry heavy traffic at the low rates common on the continent. Besides the immense differences that obtain in the capital cost of the railways, and must be provided for, in the case of private ownership, by corresponding rates and charges, there are essential differences in the conditions under which the traffic is carried. The English railways generally carry for short distances ; the American and continental railways generally carry for long distances.

The cost of handling the traffic is, however, much the same whether the traffic is carried for long or for short distances, and it makes a vast difference in the actual cost of transport whether the traffic is handled, say, once in five miles or once in fifty. It would, therefore, be a delusive hope to suppose that British traders can ever see exactly the same rates and charges that continental manufacturers enjoy ; but it would, nevertheless, be possible to modify the existing tariffs, for long-distance traffic, in a material degree, so as to enable Midland manufacturers to obtain easier access to the sea ; and this would greatly aid them in their export trade. If Staffordshire traders, for example, could reach London and Liverpool as cheaply as German manufacturers can reach Antwerp, Hamburg, or Rotterdam,—assuming approximately equal distances,—the traders of Wolverhampton, Dudley, and Birmingham would not be likely to require much more to enable them to hold their own. British railway companies may be able to arrange for this desideratum, and for giving cheap access to ports in all cases where the distance is more than forty or fifty miles, without materially altering their rates to works that are already on the seaboard, and whose transportation charges are already perhaps low enough to enable them to compete without much difficulty,—such, for example, as the traders of South Wales and Cleveland. But British trade has suffered grievously because the British railways have failed to encourage and facilitate the export trade as continental railways have done. It may be answered that the lines on the continent are controlled by the State, which is not compelled to pay dividends, whereas the primary function of the privately-owned railways of Great Britain is to return dividends to shareholders. But, if the interests of railway shareholders and national industries of the first rank are found to be incompatible, then it seems only common sense to argue that the former must give way voluntarily, or be forced to it.

Having now considered some of the more general aspects of the conditions of competition between the leading countries of Europe, we may proceed to examine their resources in raw materials, and the conditions of their supply.

Cheap raw materials are, of course, a fundamental requirement of successful international competition, and the country that possesses the largest store of such materials, all other things being approximately equal, is certain to be at the front in the long run. For this reason, it is important to consider not only the existing state of development of the iron industry, but the possibilites of future development. Regarded from this point of view, and on this basis, it might conceivably happen that the center of the world's iron production in the future would turn out to be some country, such as China or

Japan, in which, at present, the metallurgic arts have been very imperfectly developed. Meanwhile let us deal with the facts that are known.

Great Britain.—The average cost to the smelter of the iron ore raised on the west coast may be taken, including 2s. for transport, at 13s. 6d. per ton for the ores of West Cumberland, which corresponds to 3d. per unit, and at 11s. per ton for North Lancashire ores, which corresponds to 2.6d. per unit. In the Cleveland district, which is the main source of supply for home ores, the average cost of ores at the mine is 3s. and, if we add a shilling per ton to this figure for transport, it brings the average cost of a 30-per cent. ore up to 4s. at the furnace, or 1.6d. per unit. It is not easy to state the average percentage of iron in the home ores of the United Kingdom as a whole. In 1896, according to the government returns, the quantity of pig iron produced from home ores was 4,759,446 tons, and, if we take this as using 100 units per ton, it would bring up the average of the whole home ores in the country to 35 per cent., which is probably as near as we can get to the actual truth. The average cost per unit at the mines of the total iron ore production of the United Kingdom will amount to 1.54d. per unit, assuming this average of metallic iron, and the government average of value at the place of production, which is 4s. 6d. per ton; but to this figure has to be added the cost of transport to furnaces, which is not less than 1s. 6d., and this would bring the average cost of the ores at the furnaces to 6s. per ton, or 2.06d. per unit. The total production of British ores in 1896 from mines under the coal mines regulation act was 7,856,586 tons, or 60 per cent. of the total output of iron ores of all descriptions; and, as the government returns estimate that these cost 4s. 1d. per ton, and have an average of 30 per cent. of iron, the average cost per unit must be 1.6d. at the mine.

Something like thirty-three per cent. of all the pig iron produced in Great Britain is made from imported ores, chiefly those raised in the north of Spain, which cost at English ports from 11s. to 15s. per ton, according to the condition of the trade and the rates of freight, and contain from 45 to 52 per cent. of iron. If we take the average at 12s. 6d., it will be near the mark, and the average content of iron in the ore will probably be 48 per cent. This means that the average cost of imported ores at the furnaces is about 3¼d. per unit, which, it will be noted, is considerably above the average unit cost of home ores. Adding together the imported ores and the west coast hematites, it appears that about 3,500,000 tons of iron, out of a total of nearly 9,000,000, is produced from ores that will average about 50 per cent. of iron. This is a higher proportion of bessemer iron than is used in France, Belgium, or Germany, but of course it falls much below the average of the United States, which in 1895 produced 10,500,000 tons of ore from the five Superior regions, averaging perhaps about 60 per cent., and representing therefore more than 6,000,000 tons of pig iron.

Germany.—Germany has never made any great pretensions to be a cheap iron-making district. Nevertheless she produces some of the cheapest iron made in any part of the world. This is more especially the case at the works of the Peine Company, in the province of Hanover, where basic pig iron has been produced for twenty years or more at a cost of about 25s. per ton. The quantity so produced, however, is small, not exceeding 250,000 tons a year. Next to this in cheapness is the product of Alsace-Lorraine, where the average value per ton of the 829,000 tons made in 1895 was returned officially at 32½ marks, and following Alsace, on a large scale, comes Luxembourg, with an output, in the same year, of 695,000 tons, officially valued at 37s. per ton. By far the largest output of iron in Germany is, however, drawn from Westphalia. The Bonn and Dortmund districts unitedly produced in 1895 more than 3,000,000 tons, or nearly 60 per cent. of the total output of the empire. The average value of this output is estimated at about 44s. 6d. per ton, and the average of the whole pig iron output of the empire is officially recorded at 42s. 10d. ($10.41) per ton. This does not compare unfavorably with the average value of British iron at the same date. The bulk of the iron produced in Germany is basic, and Cleveland basic iron varies from 42s. to 45s. per ton. German hematite, or so-called bessemer, iron is quite as cheap as the corresponding quality in Great Britain.

Germany cannot be said to enjoy the most suitable conditions for the manufacture of cheap iron. In the chief iron-making district, Westphalia, the ore has mainly to be drawn from three districts,—Alsace, Luxembourg, and the Meurthe-et-Moselle. All of these districts are far removed from the coal and the blast furnaces of Westphalia. Railway transport consequently brings up the cost of the ore at the furnaces to about three times its value at the mine. In other words, the cost of the ore required to produce a ton of basic pig in Westphalia is not less than 18s. per ton, against about 14s. in Cleveland, so that here there is a distinct gain for the British maker. It is true that considerable quantities of pig are produced in Alsace-Lorraine and in Luxembourg, but in both cases the fuel has to be carried a long way to the ore, and the conditions of transport distribution are in neither case so favourable as in Westphalia, where, consequently the pig iron industry has witnessed its largest development. Beside the ores available within her own borders, in which Luxembourg is included as part and parcel of the Zollverein, Germany imports considerable quantities of both basic and bessemer ores—the former from the Meurthe-et-Moselle, to the extent of about 1,250,000 tons a year, and the latter from Spain and Sweden, to the extent of about 750,000 tons annually. The German imports of ore, which aggregate more than 2,000,000 tons a year, are not much more than one-third of those of Great Britain, but they are much larger than those of any other continental nation, including France, which now imports nearly 1,750,000 tons annually. The Meurthe-et-Moselle ores are abundant and cheap. They run to about $\frac{1}{10}$ per ton at the mine, but, before they are delivered in Westphalia, they cost quite as much per unit as the ores of the Lorraine and Luxembourg. So far as the importation of bessemer ores is concerned, Germany stands at a disadvantage in comparison with Great Britain. All such ores have to be transported by sea, and the iron works of Westphalia are not so favorably situated for water-transport as those of Cleveland, Wales, and Scotland, which are practically on the seaboard, although the Rhine freights are very low, and canal freights off the Rhine are much lower than shippers have any experience of in Britain. It is possible, in the main, that the difference against Germany will not be more than 1s. to 1s.6d. per ton, which would mean 2s. to 3s. on the ton of pig. It is a notable phase of the recent history of the German iron industry that it has used a much larger proportion of Swedish ores than Great Britain, which depends mainly on the north of Spain. Krupp, however, has a large interest in the Orconera Iron Company,—the chief mining enterprise in Spain,—and imports a very considerable quantity of Orconera ores to his works on the Rhine at probably as low a price as is paid by any of the works in Wales or Scotland.

The greater distances that intervene between the ores and the fuel are a serious disadvantage to Germany. In no case is the distance much less than a hundred miles, and in many cases it is much more. In Great Britain only one district is subject to this serious disadvantage,—namely, the West Coast, which draws its main supplies from South Durham, on the other side of the island, and well on to a hundred miles distant, at a cost for transport of 6s. to 7s. per ton. On the other hand, Cleveland is within thirty miles of the important coal field of South Durham, whence she draws her fuel supplies at a cost of 2s. 6d. per ton for transport, and in South Wales and Scotland, as well as in some of the Midland districts, the blast furnaces are built on the coal. Throughout Great Britain, indeed, cheap fuel is, with rare exceptions, the general rule, and where iron-making firms produce their own fuel, as many do, the cost of this item must be relatively small.

Belgium.—Perhaps no country on the face of the earth has ever attained to a position of eminence in the face of such disadvantages and discouragements as Belgium. She has now practically no ores of her own, and her home supplies were always poor and dear. Consequently she is compelled to import the great bulk of her requirements. Her coal is generally inferior to that produced in any other European country, and so difficult to mine that a Belgian hewer cannot produce much more than one half of the annual output per hewer in Germany or Great Britain, or the United States. Belgium was also originally badly off for ports, and even now she can be said to have only one of any consequence. Her coal fields, again, were a long way from the sea, so that, if works were built on the coal, they had to suffer the disadvantage of a long railway or canal transport for export purposes. Yet, in spite of all these and other disadvantages, the little kingdom has won a place of no small importance among the iron-making nations of Europe, and competes with Great Britain and to some extent with the United States, on their own soil. This result has been accomplished by dint of very great industry and exceptionally economical labor, as well as by an energy and enterprise that deserve high praise.

Practically all the large iron works in Belgium are situated on the coal fields, mostly on those of Liège and Charleroi. The Luxembourg ore usually costs about 6s. to 6s. 6d. per ton at the works in the Charleroi district, which is about the Westphalian average, but less by at least 15 per cent. taking the quality of the ore into account, than the Cleveland ores cost the smelters of Middlesborough. The Belgian pig makers have to bring a 35-per cent. ore distances varying from 100 to 130 miles; the coal, which is got on the spot, or nearly so, costs 6s. to 8s. per ton at the furnaces, the cost at one works which I visited, only about 1¾ miles from the collieries, being as much as 7s. 11d. per ton. This compares curiously with one works I know of in the neighborhood of Pittsburg, some twenty miles from the collieries, where the coal is delivered at furnaces for less than 2s. 6d. per ton, and it also compares unfavorably with all the British works, except those on the west coast. At another works I found that the average cost of coal, including slack, at the pit's mouth, over a period of six months, was as much as 7s. 7d. And yet these same Belgian workers can produce pig iron for £1. 15s. to £1. 17s. 6d. per ton ($8.50 to $8.63).

Of course, Belgium, as will be inferred, makes up for costly raw materials by low rates of freight. Ores are carried a distance of 130 miles for about 4s. per ton. Bar iron is carried more than a hundred miles for 3s. per ton when destined for export. Low freight rates and low wages are the salvation of the country. I must leave until another occasion the consideration of the competitive conditions of the United States and one or two other countries.

THE PROTECTION OF SHORES AGAINST THE ENCROACHMENTS OF THE SEA.

By E. L. Corthell.

WE are accustomed to consider the old Dutchman to be the great and successful sea-fighter, whose habits of vigilance and continued effort in the midst of grave danger and in the presence of a powerful enemy gave him the persistent courage to combat for a century or more the legions and the power of Spain. The facts of history do not justify this opinion. He may have been, and he was, a redoubtable fighter against foreign rule and oppression, but he never successfully attempted to cope with the sea. He built a wall of earth about his farm, set his wind-mill at work to pump out the water, spread black soil over the sandy parts, and raised his crops while the surrounding lands were flooded ; but further he did not go. As an illustration of this condition, the city of Alkmaar, which means "All Sea," was originally a bit of higher land, with lakes all about it. This large area of country was reclaimed by building about it an extensive levee, almost circular in form, pumping out the water, digging drainage ditches, and making farms. This became then the seat of the old kingdom of the counts of Holland ; but the encroachments of the sea were never combatted. The real hero of Dutch history is the engineer of the last half-century. It was only after 1860 that he said to the sea : "Thus far shalt thou come, but no farther." None of the generations preceding had the nerve to say this, or the skill or resource to make the sea obey the command.

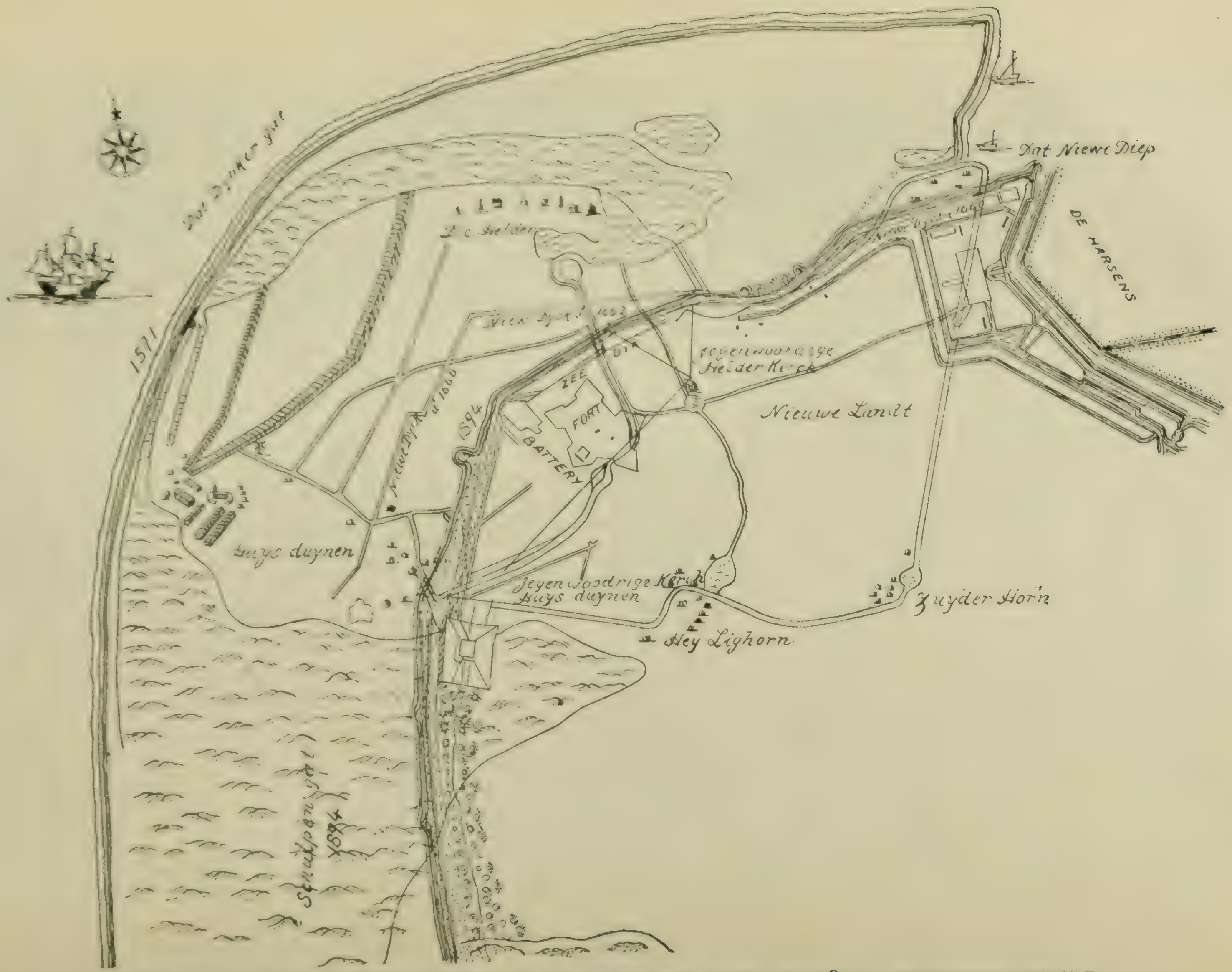
The North sea continually encroaches upon the beaches and cliffs on both its east and west shores. Nearly the entire coast of the counties of Norfolk and Suffolk, in England, is melting away before the waves in greater or less rapidity. The sea slowly, but surely, removes the bluffs, which slip and slide, carrying with them villages and towns that, in the olden time, were among the more important of the kingdom. At Cromer, for instance, the waves break over heaps of *débris* which once were the brick wall of a lighthouse. The Cromer of old Roman times cannot be located. It is said to be two miles out at sea. In Suffolk the little old-world village of Dunwich is only the remains of a once flourishing town. King Sigebert, of East Angles, had here the seat of his government. In the Norman conquest it began to feel the encroachments of the sea. Even during the reign of Henry the Second it had a great reputation and was very rich, with fortifications of sufficient strength to defy the invading troops of Henry's son. In the days of Edward I it maintained eleven ships of war. Then the sea went to work in earnest; it first blocked up the port with sands,—about 1328,—and, in a comparatively short time, swept away more than four hundred houses; then a church went, then a monastery, then at last the jail. In the time of Elizabeth four out of six churches had been drowned in the sea. In 1891 the population had shrunk to two hundred and thirteen, and those live in terror in a straggling little village in an inland valley, whither they have fled from the all-conquering and advancing sea.

On the opposite shore of the North sea, about three hundred and fifty miles distant, the same process of decay of the land, and the destruction of its cities, went on until about 1860. The writer, through the courtesy of one of the Dutch engineers, is able to reproduce in THE ENGINEERING MAGAZINE (p. 404) a historic chart, long out of print, which shows the changes in the coast line and in the cities and cadastral features since 1571. A map of Holland will show the precise location of Helder, which is its most northern main-land city.

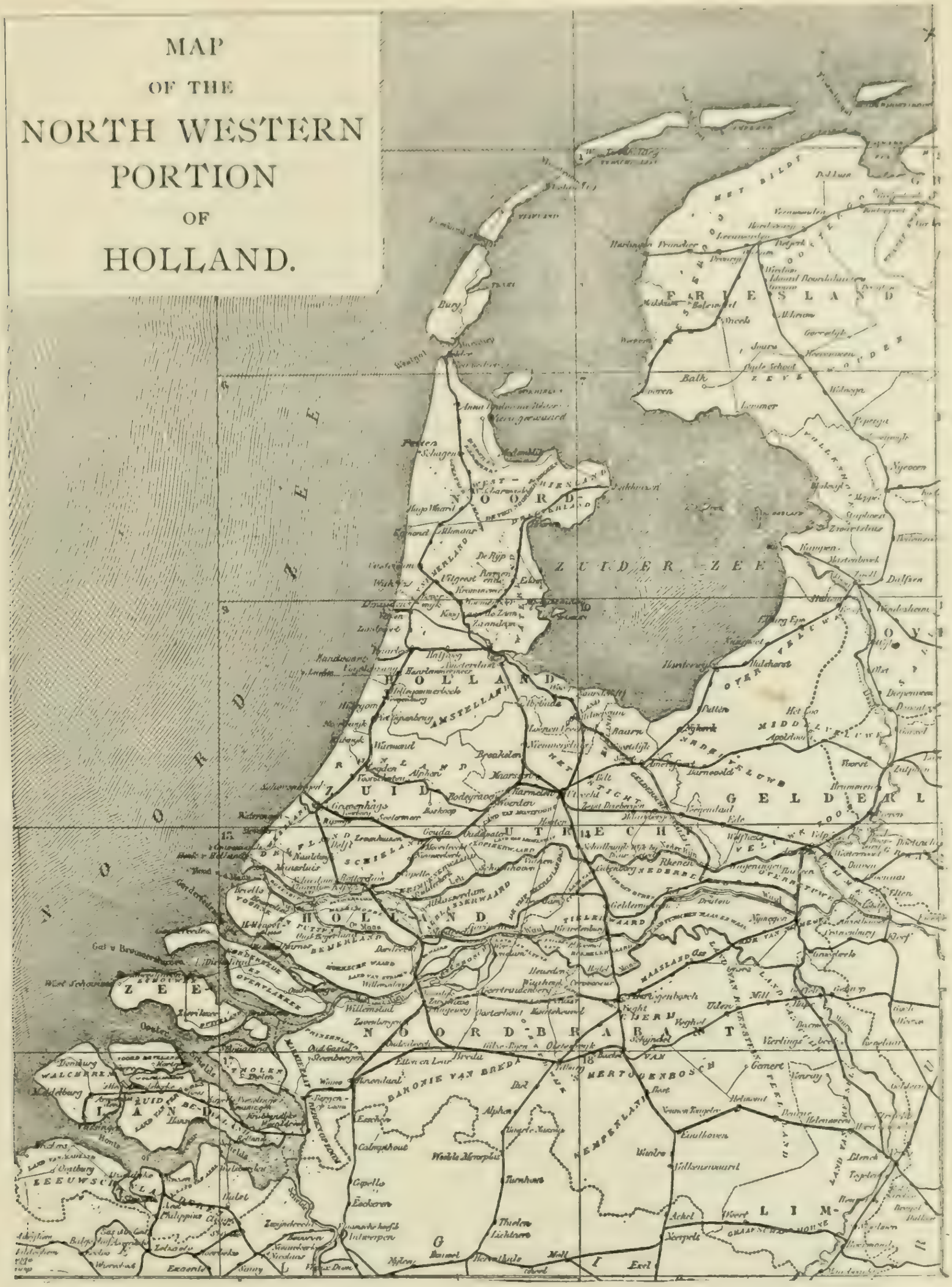
The outer shore line of the historic map is that of 1571, more or less accurate. The inner shore line is that of 1894, which is the present one. This line has been effectually held since 1866. The old sand dunes of three centuries ago are plainly seen, as well as the successive retirements of the population from the ever-encroaching sea. The town of Huisduinen is now 1,500 meters from the shore line; the old Helder 1,000 meters; both buried in the sea, the waters covering all that may be left of once flourishing towns. The lines of old dikes, the results of half-hearted efforts to brave the sea, appear on the map. Farther south the same conditions exist, though in a somewhat modified form. Opposite Leiden, not far north of The Hague, there is said to be still an old castle, or the ruins of one, far out at sea. It was built in Roman times, before Christ, and was discovered by the surveys of about a century ago; since then there has been no indication of it, though no doubt it is there yet.

At Scheveningen, the watering-place of Holland, near The Hague, and all the way south to Ymuiden, the sea-entrance of the Amsterdam canal, the sea has, until recently, constantly encroached on the land; and the old charts of the eighteenth century show the shore a kilometer distant from its present position. On the island of Walcheren, and on the main land as far south as Ostende in Belgium, the same effects of the sea are found.

The principle on which engineers of the present generation have based their plans and methods are simple and effective. The great destructive forces of nature have been skilfully turned into construc-



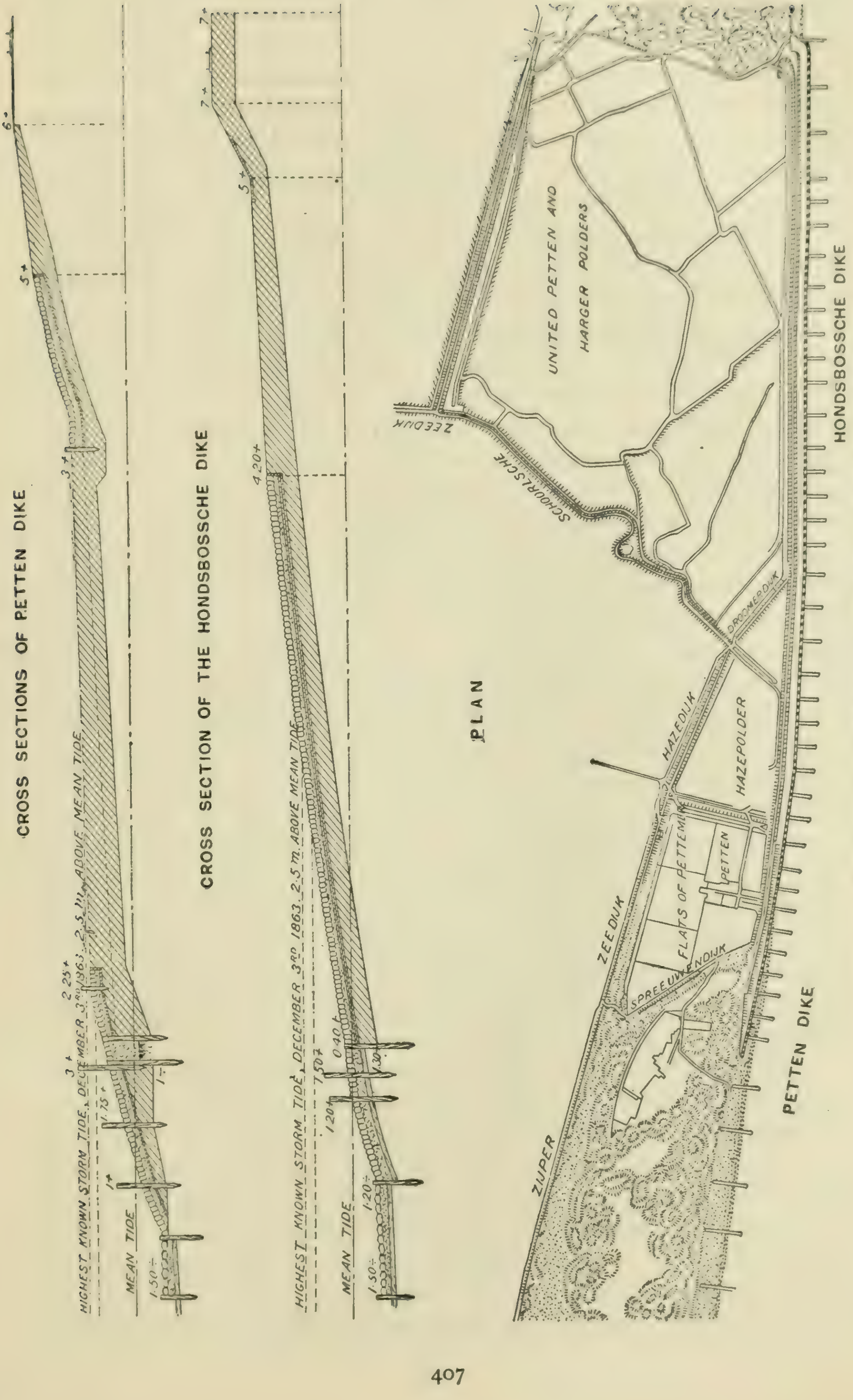
THE COAST OF HUISDUINEN, HELDER, AND NIEUWEDIEP IN 1571 AND 1894. FROM AN OLD CHART.


MAP
OF THE
NORTH WESTERN
PORTION
OF
HOLLAND.

tive forces. Appreciating the fact that the high chalk cliffs of England are no protection against the sea, they did not attempt to place an artificial vertical wall against the waves and the storm tides, but coaxed the sea to deposit its sands on the shore and so build it up, rather than throw them inland and then, hungry for more, eat into the shore. They believed it best to satisfy its appetite, but induced it to toy with the sands which its own flood-currents and waves bring from other shores and from the offing depths. The sand thus deposited blows, in the gales, over the inland country. The engineers induced it to stop and build a barrier for them against the sea. One of the heaviest dikes along the coast was built by the winds themselves.

Illustrations of the works at many different points might be given, but one will suffice, especially as it is one of the best examples of the methods employed. It is at the small village of Petten, about fifteen miles north of Alkmaar, and not far west of the North Holland canal, which traverses the country almost due north from Amsterdam to Helder. The lower marginal line of the sketch is due north and south. The sand dunes are sketched at the right and left, between which is the sea dike, built many years ago, but entirely reconstructed from 1870 to 1880. Its length is 5,500 meters (18,000 feet), of which 4,500 meters is under the charge of the Polder (an area or combined areas of embanked land with its own local government, like a town or city) and 1,000 meters under the charge of the federal government. The Polder dike cost 2,250,000 florins ($904,-500) and the government dike 500,000 florins ($201,000). The government furnished 4,000 florins toward the expense of the Polder dike, and the province (State) 4,000 florins. The remainder of the cost was put upon the lands and other property of the Polder under a general law of Holland, which also authorizes the issue of long-time securities or bonds. There are twenty-nine Polder jetties and nine government jetties, with eleven more government jetties built further north. The upper cross-section is the sea-slope of the government dike, and the lower that of the Polder dike. The land slope is about 2 to 1, and it and the crown of the work down to 5 meters (16.4 feet) above mean high tide, which is 0.68 meters (2.23 feet) above A. P. (Amsterdam Peil, or mean level of the sea as established at Amsterdam), is turf, except where paved with stone. The hatched area is a tough clay obtained at some point inland and spread over the sand or other material forming the interior of the embankment, which is obtained from borrow pits on the inside at some distance from the work. As the government section is rather more scientifically planned and built, the description of the details will refer to it.

The entire slope, up to the 6-meter height, is liable to have a sea upon it. The waves of the storm of December 12 and 13, 1883, reached to 5.7 meters (18.7 feet), and the level of the water December 3, 1863, was 2.50 meters (8.2 feet) above mean high tide. The rock-work of the surface of the slope is entirely of basalt, which is used everywhere in Holland,—found at Andernach, on the Rhine, in Germany. It is always hexagonal, and usually eight to eleven inches in thickness. It is columnar when in position. The columns are



SECTIONS AND PLAN OF THE SHORE-PROTECTION WORK AT PETTEN.

broken off into lengths of twelve to eighteen inches, and are placed on a mat or filling of small, lithe, osier willows, which are either made into fascines or bundles, about 5 inches in diameter and sometimes of great length,—40 to 60 feet,—or packed in layers on the clay slope, as shown in the sketch. A row of stakes is driven firmly into the clay to separate the rock-slope from the clay surface adjoining. The long flat clay slope between this rock covering and the sea-slope is overlaid every autumn, after the threshing season, with wheat straw, which is laid in layers, like shingles, except that the butts are covered over, and the layers are fastened down to the clay by withes of straw laid parallel with the dike and pressed into the clay about six inches every six inches of length of the dike. This is done by means of a peculiar iron tool, or chisel, the end of which is hollowed out in circular form to catch the straw withe and jam it down into the clay. The covering of new straw presents a beautiful appearance, and feels under the feet like a soft carpet. It maintains itself under the storm wave-action about a year, when it becomes rotten. It is then pulled out, and a layer of new straw put down. This is less costly than the use of basalt, as the latter is expensive.

The sea-slope proper is much more solidly and permanently built; the rock is packed tightly, and the stakes, or small piles, are much larger, and stand up higher above the pavement. They are about one foot apart, and their diameter is five to six inches. The object of these is two-fold: to assist in holding the stone in place,—there are four rows standing above the rock-slope and four flush with the surface,—and to break the waves without stopping them, and thus protect as much as possible the flat straw slope above.

It will be seen from the section that the work extends from about 2 meters (6.5 feet) below the mean high-tide level to 6 meters (19.7 feet) above it, or a total height of 8 meters (26.25 feet), and is, including the inside slope, about 77 meters (253 feet) in width. The entire slope averages 1 in 8; but the matted slope, 27 meters (88.6 feet) wide, has a slope of only 1 in 40, while the foreshore of pitched basalt next to the sea has a slope of about 1 in 4.

This construction, however, is comparatively simple. The real effective effort is in the construction and maintenance of the forty-nine spur jetties, or groins, shown on the plan. These are generally spaced about their length apart, or possibly a little more,—say 1¼ times the length of the dikes. They are built of willow mats made of fascines, and loose willows pinned and packed down solidly, with a covering of basalt about eighteen inches in thickness. With a less thickness than this, the waves will churn up and pull out the stones. There are usually, lengthwise of the jetty, six or eight rows of stakes, not far apart, driven down until the tops are flush with the stone. The interstices between the stones very soon become packed with barnacles and masses of small black shells, which materially assist in holding the stones in place. The jetties are generally about 105 meters (350 feet) long and 12 meters (40 feet) in width. One of the first and desired effects of these jetties is to make a deposit of sand between them, extending from the shore line to and beyond their outer ends, in many cases covering their side slopes and securely protecting them. The extreme ends are the only exposed points, and these need considerable maintenance-work. Small piles in squares are driven by hand through the end of the work, which serve the same purpose as the piles driven in the embankment slope above described.

The sand formed between the jetties becomes dry in sunny weather, and the surface is blown ashore when the wind is in that direction. It was desired to build a strong dike to connect with the sand dunes. This was accomplished by setting in the sand, in rows about a foot apart, tufts of the dune sea grass near by. The tufts were placed about a foot apart,—simply little handfuls of grass; the place for each tuft was dug out with the hands, the tuft set into it, and the sand pressed around it. The whole surface of the dry, sandy beach above high tide was covered with this plantation, and, just back of it, at the highest point of the existing sandy area, one or two rows of reeds were set into the sand, their tops cut off, and the stalks left standing about four feet above the sand. The sand, drifting along over the surface, catches and in one windy day will almost bury the tufts of grass and stand up a foot along the rows of reeds. Then another plantation was made, and another, until a massive dike was built up to the height of the adjoining dike. In high storm tides the waves will eat into the toe of the slope and pull down the sand, but, by the same process of building, the dike is again restored to its former size.

The shore immediately south of the southern end of the main dike and the last groin shown in the sketch some time ago showed signs of the encroachment of the sea. The plan of planting tufts of grass was adopted for a long distance, very successfully, holding the shore in position. The cost of maintaining the entire work, Polder and government, is about 25,000 florins ($10,050) per annum. Considering that this is the key-work for all this part of Holland, the expense of maintenance is very small.

About midway of the work is seen an interior dike, called "Droomerdijk," striking the main dike diagonally. This diagonal dike formerly extended in its present direction a long distance into the sea, possibly at a time when, as at Huisduinen, the country was protected by a mass of high sand dunes. These dunes often attain a height of one hundred and fifty feet above the sea, and form a mass of hills and valleys. The dunes shown at the right in the sketch are of this character, and, along the road leading from the shore and skirting their base, are several very pretty villages, protected from the winds and having in front of them the lands,—the rich polder,—which, as shown by the name, "Pettemer," was formerly a sea.

The principles, methods, plans, and details do not differ materially along the whole coast, from Ostende to the Dutch Islands north of the main land, covering a coast line of nearly two hundred miles.

The natural and artificial conditions are full of interest. First, the peculiar movements of sands in the flood currents up the channel and along and in front of the French and Belgian shore, attempting always to close any artificial outlets, like those at Calais, Dunkirk, Gravelines, and Ostende. These moving reefs of sand back up against the works, and then move around the ends of the piers into the channel, obstructing navigation if not removed by dredging. At a distance from the shore these reefs require removal. They seem to be moving northward up the coast to furnish material with which the sea may build sand dunes along the Holland coast; for the supply of sand there seems almost inexhaustible.

Second, the action of the sea upon the shores,—in one place building, in another tearing down. Not far north of Ostende, the shore, some time ago, was washing away; a huge masonry dike was built to stop it; and then, by one of those peculiar periodic reversals of policy which sometimes possess the sea, as we find it on that wonderful coast of Coney Island, the currents and the waves and the winds formed a combination, buried the dike deep under a sand dune, and built a hill in front of this masonry wall. Thus to a stranger the object of the dike does not appear at a glance. Not far north of this same point the shore, and the dunes with it, are receding at the rate of seven feet per annum.

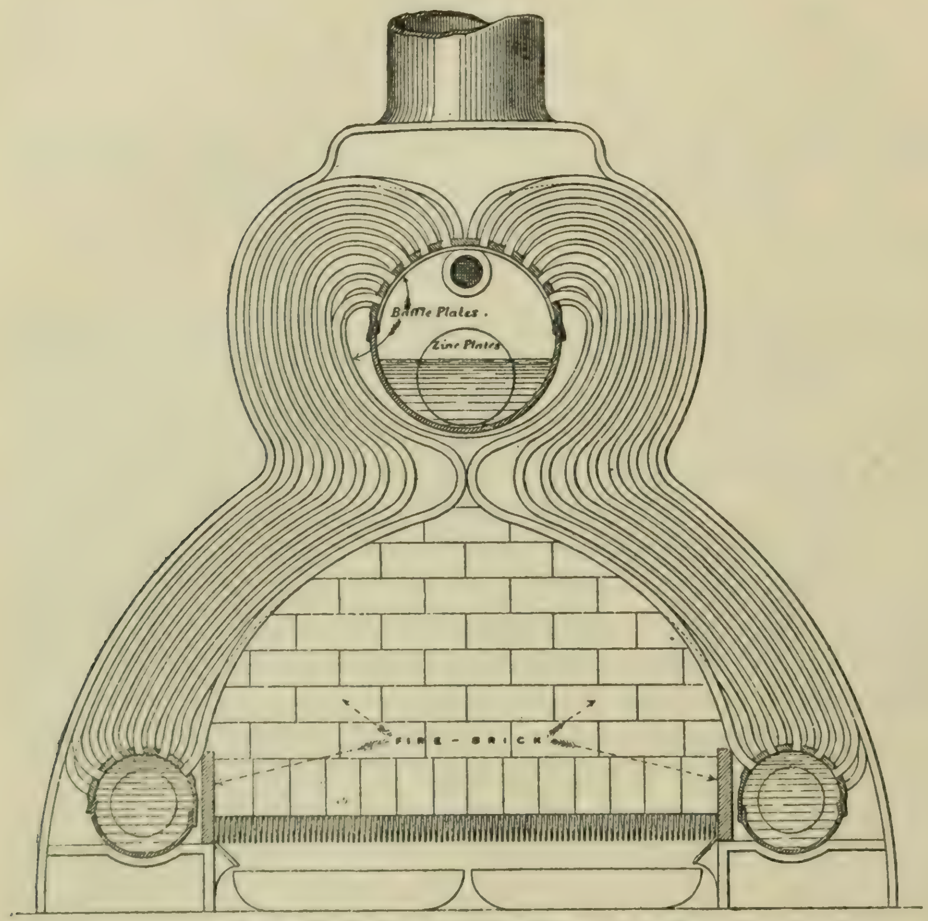
Third, that shore which we have specially treated in this paper, where the sea is everlastingly encroaching upon the land; where currents and waves and winds seem to conspire to destroy it; but where, often by the frailest of works and most perishable of materials, skilfully employed, the Dutch engineers are victors in the long, hard battle with the sea and its allies.

THE STATUS OF THE WATER-TUBE BOILER IN THE AMERICAN MARINE.

By Walter M. McFarland.

THE two items of greatest interest in connection with marine machinery at the present time are, probably, water-tube boilers and the steam turbine. The latter, for marine purposes, was not long since spoken of by a distinguished engineer in London as an interesting toy, but the former is the subject of the most careful and painstaking study, design, and experiment by many of the most talented engineers in the world. Indeed, so great is the interest in water-tube boilers that we seem on the eve of a revolution in the marine steam-generating plant, and in the navies of at least two of the great powers the revolution has been so far accomplished that for new designs the cylindrical boiler has been definitely abandoned. To understand how this has come about, a brief consideration of the history of this well-tried type will be profitable.

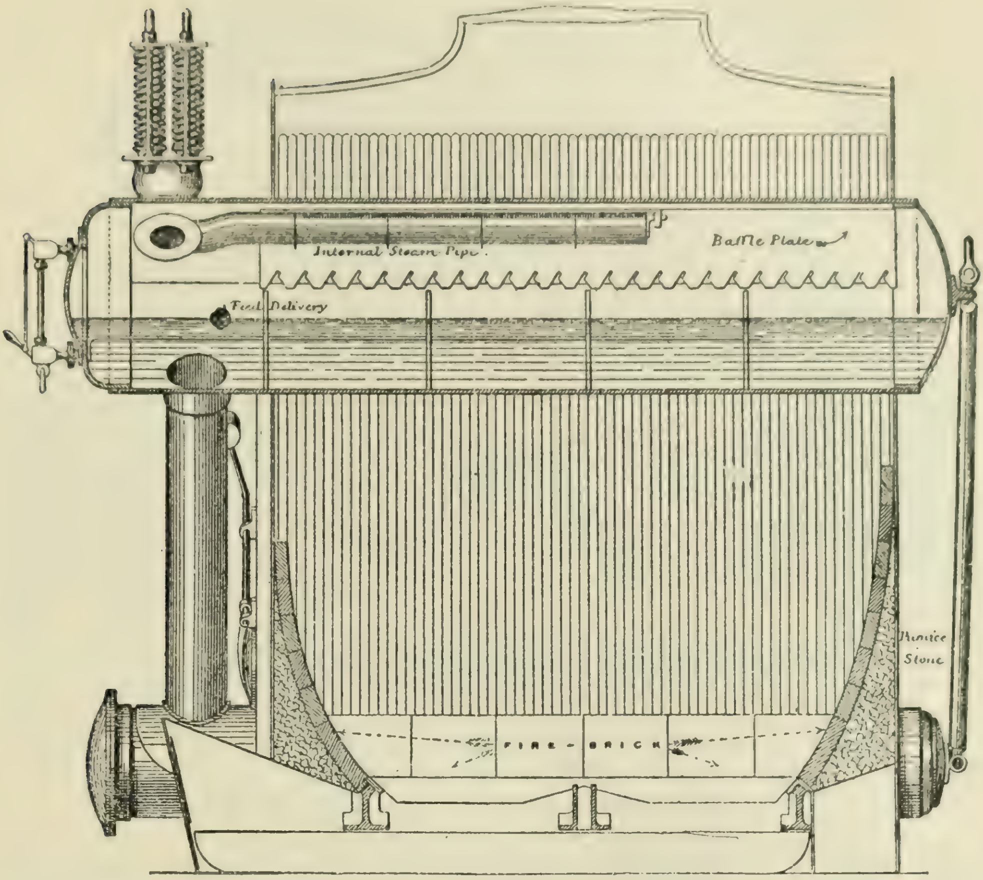
Evolution is not restricted to biology, in spite of the fact that, to many, it is almost synonymous with the views of Darwin and Huxley ; and it can be easily traced in the history of boilers. In early days, when steam pressures were low, boilers were of almost any shape, depending for their strength on bracing rather than thickness of shell. As pressures rose, a time came when the braces would have been too close to permit access to all parts of the boiler, and this naturally led to a form where the envelope could furnish the necessary strength by its thickness, and dispense with bracing. This brought in the cylindrical, or Scotch, boiler, and, after some years of trial of various details, a few standard types gained general adoption, variation being mainly in size. About the time that mild steel came into general use, pressures had risen to the permissible limit for shells of wrought iron, but the new material enabled the progress with higher pressures to continue. Improvements in manufacture of material, in boiler-making appliances, and in design enabled the cylindrical boiler to answer every demand upon it, until pressures as high as 225 pounds, for boilers that may not inappropriately be called huge, are actually in use to-day. The boilers of the Campania are 18 feet in diameter and 17 feet long, and the shell plates are nearly 1⅝ inches thick, some of the individual plates being 20 feet long and 7 feet wide ; the working pressure is 165 pounds.. The St.



THE THORNYCROFT WATER-TUBE BOILER.
"Speedy" Type, Front View.

Louis and St. Paul, with a working pressure of 210 pounds, have boilers 20 feet long and 15 feet 7½ inches in diameter. The main boilers of the U. S. S. Minneapolis are 20 feet long and 15 feet 9 inches in diameter, and weigh about 72 tons each, empty. The water in one boiler weighs about 40 tons.

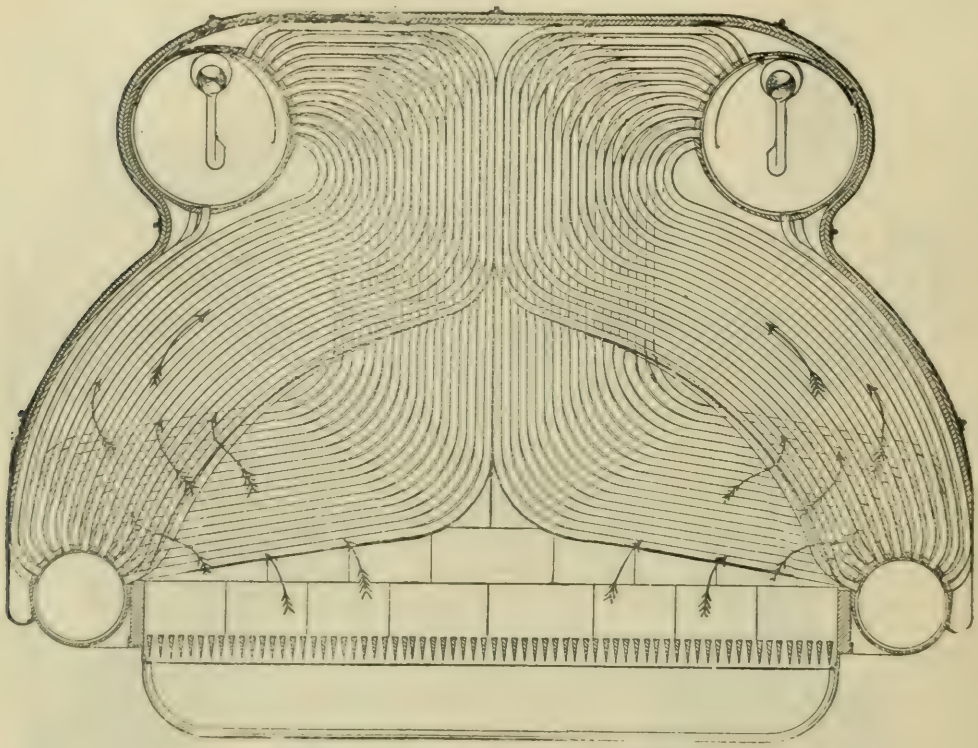
Two of the disadvantages of the cylindrical boiler are here shown very clearly,—the great weight of the boiler itself and of its contained water. The figures themselves are striking, but a tabular comparison farther on will emphasize the great weight for a given power. Incidentally it may be remarked that these large boilers require a large plant with massive tools for building them. It will be readily appreciated also that a structure composed of so heavy plates must be very rigid, while the ideal boiler should be very flexible. This rigidity necessitates ample time and considerable care when raising steam, and when allowing it to fall after the boilers are no longer needed; in the attempt to equalize temperature throughout the structure, special devices for circulating the water are almost invariably



THE THORNYCROFT WATER-TUBE BOILER.

"Speedy" Type, Longitudinal Section.

employed. Hauling fires, except in an emergency, is no longer permitted, as it certainly causes leaks. It is practically certain, too, that the limit of steam pressure with cylindrical boilers has been reached. Although a few large vessels are in use where cylindrical boilers carry more than 200 pounds' pressure, the pressure generally does not exceed 180 pounds. For these high pressures the work of building a large boiler is difficult and expensive, and requires a costly plant. It is to be noted also that the great weight of water in these large boilers is an element of serious danger in case of an explosion, although happily there is, as yet, no record of a modern, well-designed, high-pressure boiler having exploded,—a very creditable thing for all concerned in design and manufacture. It was Dr. Thurston, I believe, who said long ago that a cubic foot of water heated to a temperature corresponding to 60 pounds' pressure had as much explosive energy as a pound of gunpowder. At the higher pressure now carried this would be increased by about twenty-five per cent. While there have been no explosions of the boilers, there have



THE MOSHER WATER-TUBE BOILER.
As used on the "Feiseen," "Norwood," and other swift boats.

been ruptures of the steam pipes, and the large amount of highly-heated water has continued to fill the adjacent compartments with steam, sometimes for several hours, thus preventing any succor reaching those who, but for this, might have survived, although badly injured.

It thus appears that the defects or disadvantages of the cylindrical boiler which have made themselves felt and have called for a remedy are:

Inadequacy for pressures higher than about 200 pounds.

Great weight of the boiler itself.

Great weight of the contained water.

Excessive rigidity, entailing time and care in raising and lowering steam.

Slowness in raising steam,—a great defect in war vessels.

Disastrous results from an exploded boiler or ruptured steam pipe.

To reduce the weight of boiler and water per unit of power, recourse has been had to forced draft, and, while this has accomplished its aim to a certain extent, it has been accompanied, in many cases, by injury to the boilers, and, when the amount of coal burned compared to the heating surface has been high, it has always caused a decided reduction in the economy of evaporation. This will be seen from the annexed table and diagram, which, although made from trials of a water-tube boiler, are true generally.

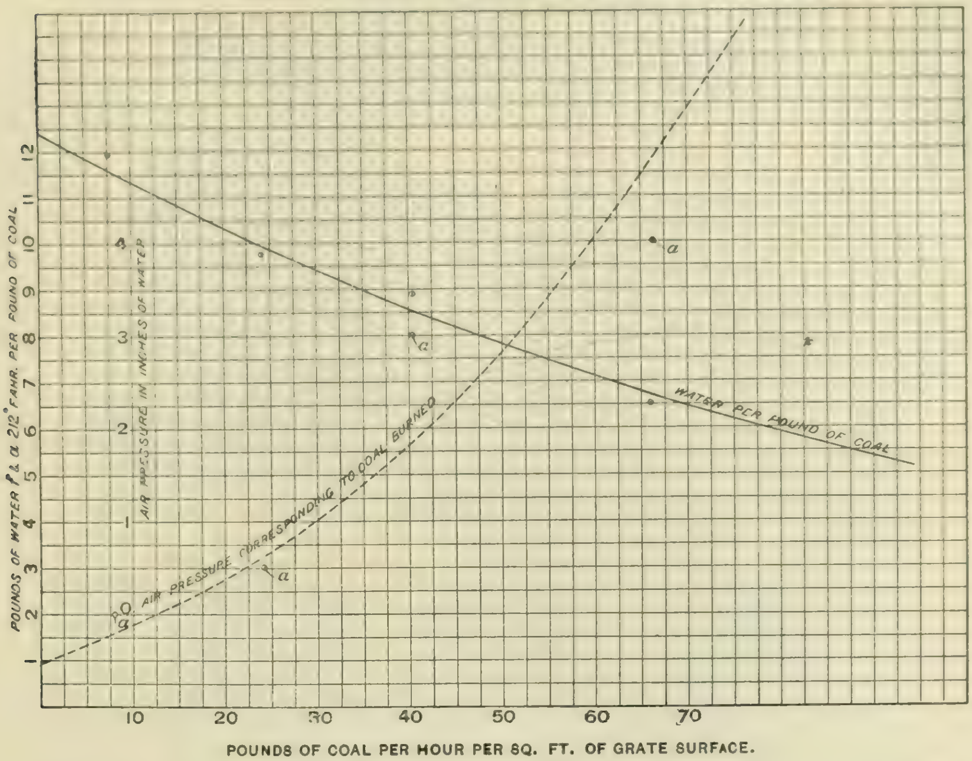


DIAGRAM SHOWING RELATION OF EVAPORATION, COMBUSTION, AND AIR PRESSURE FROM TESTS OF A THORNYCROFT BOILER ON U. S. S. CUSHING IN 1891.

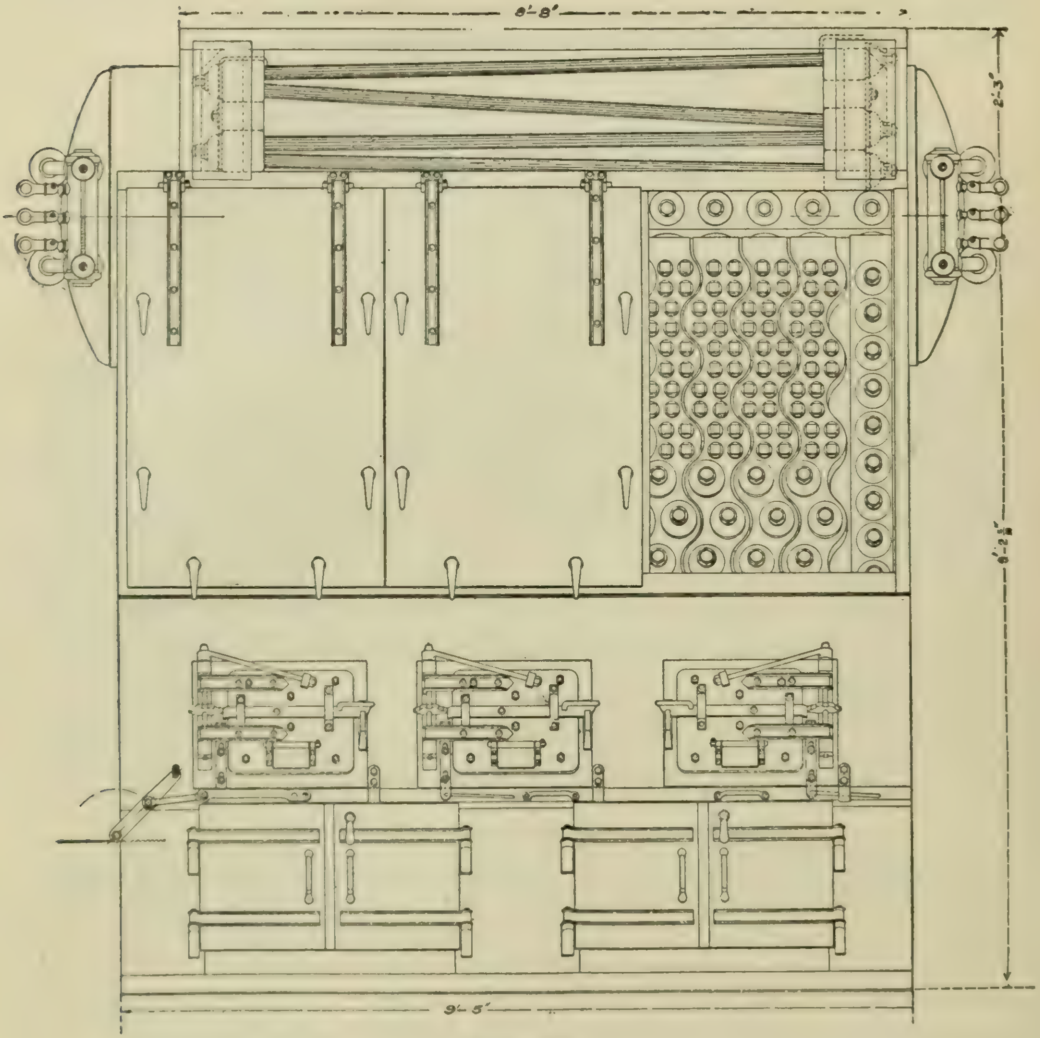
G.S., 38 sq. ft.; H.S., 2451 sq. ft.; H.S. ÷ G.S. = 64.5.

TABLE I. Tests of a Thornycroft boiler, with varying rates of combustion.

Air pressure, in inches of water	*0.00	0.5	3.0	4.0
Steam pressure, per gage, lbs	250	250	250	250
Coal per hour per sq. ft. of grate surface lbs	7.58	24.12	40.23	66.32
Actual evaporation f. & a. 212° Fahr. per lb. of coal	11.90	9.72	8.84	6.51
" " " " per sq. ft. of heating surface	1.40	3.63	5.51	6.70
Horse power per 100 sq. ft. of heating surface, on basis of 20 lbs. of steam per hour per I. H. P. f. & a. 212° Fahr	7.00	18.15	27.55	33.50
Horse power per ton of boiler and water on same basis	15.6	40.44	61.38	74.65

* Blowers discharging into open fire-room.

The water-tube boiler is sometimes spoken of as "the boiler of the future," which might lead many to suppose that the type is very new, but such is not the case. Even in modern form, they have been in use on land for more than forty years, and the patents for some of those of the marine type are at least forty years old. Their

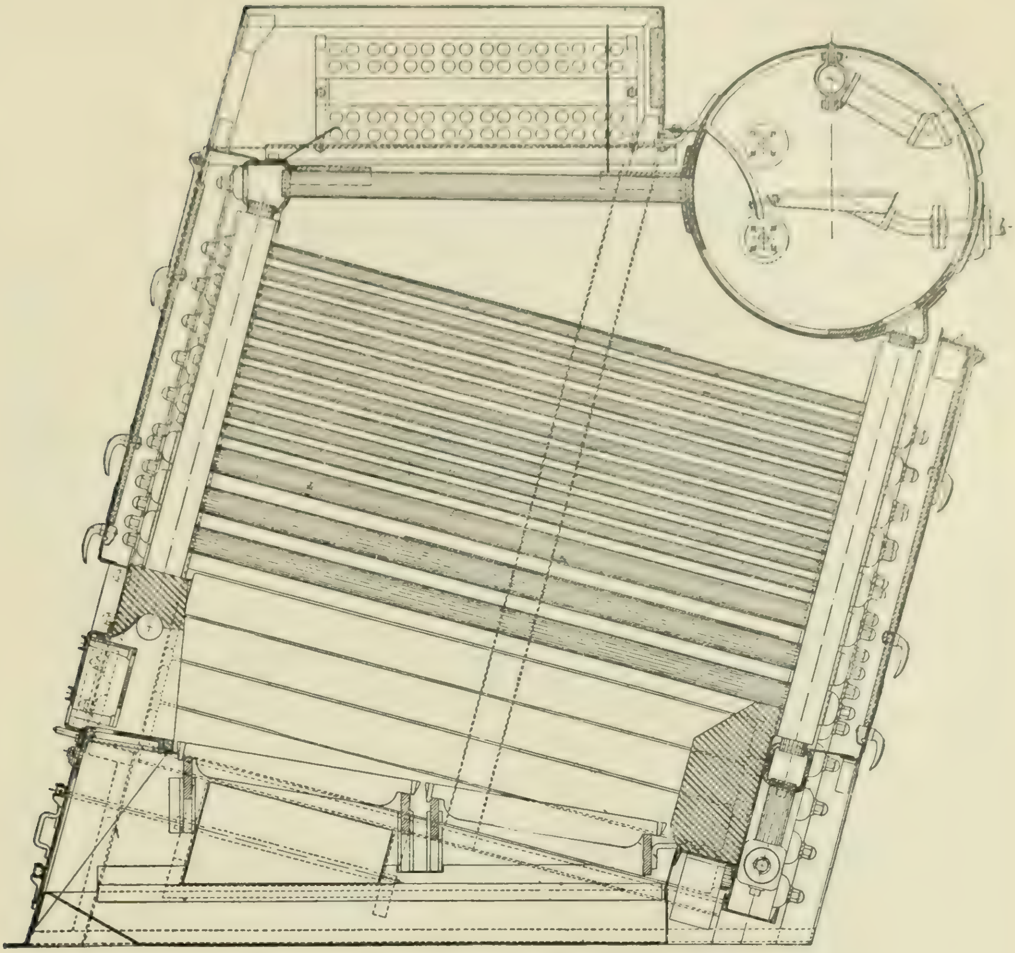


FRONT VIEW.

THE BABCOCK & WILCOX WATER-TUBE BOILER.

extended use, however, has occurred only in the last ten years. After discussing their advantages and disadvantages,—for they are not perfect,—we may consider the reasons which have prevented their more rapid introduction in the past, and those which now make it almost imperative to use them.

Water-tube boilers consist essentially of numerous tubes, of relatively small diameter, which constitute the heating surface, connecting one or more steam drums to one or more water drums, the water being on the interior of this system ; while the exterior is surrounded by the hot gases of combustion which are contained in an envelope, which latter may be entirely of sheet iron and fire-brick or other non-conductor, or a row of contiguous water tubes inside of such a casing. We see at once the main reason for the reduction of weight in the dis-



SIDE VIEW.

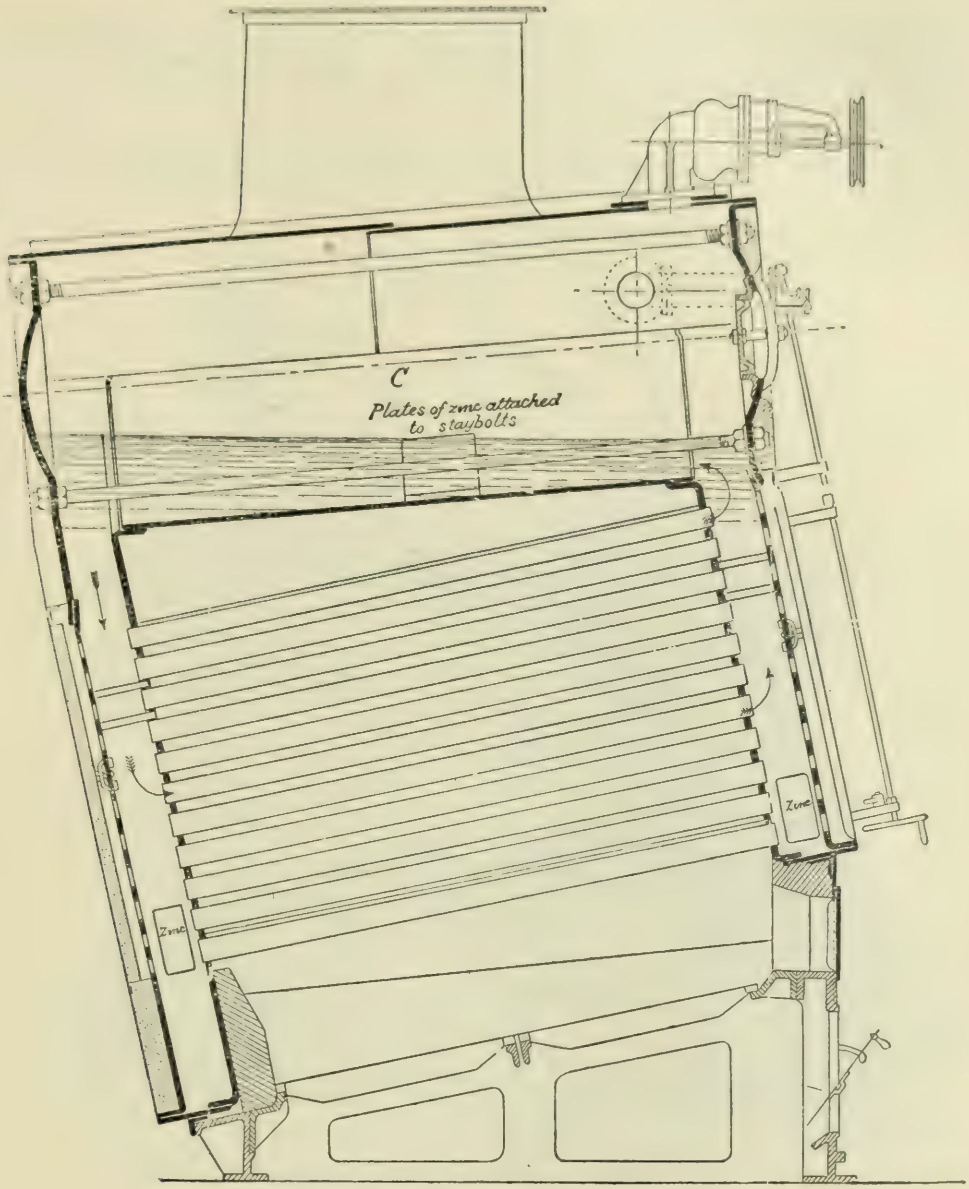
THE BABCOCK & WILCOX WATER-TUBE BOILER.

appearance of all the enormous plates of the shell and heads of the cylindrical boiler. In the water-tube boiler the plates are usually parts of small cylinders, and are thinner than the thinnest plates of the older type. The reduction of weight of contained water is even greater proportionally. Table II. gives the data of size, weight, and performance of a number of boilers of both types, with and without forced draft, and for merchant and naval vessels. The heating surface is the real measure of the power of a boiler, and the weight per square foot of heating surface therefore gives a good basis of comparison where the rates of combustion are the same. The other lines of the table enable account to be taken of varying rates of combustion, and it is to be noted that it is not unfair to the cylindrical boiler to compare such a case as the Ward boiler, burning 55 pounds of coal per square foot of grate, with that of the Newark, burning 40 pounds, as it is an indication of one of the advantages of the water-tube boiler, —ability to stand harder forcing without injury.

TABLE II. PERFORMANCE OF VARIOUS MARINE WATER-TUBE AND CYLINDRICAL BOILERS.

Kind of Boiler	Water Tube.				W. T.	W. T.		W. T.	W. T.	Cylin.	Cylin.	Cylin.	W. T.	Cylin.	W. T.
Maker or Style	Thornycroft.				Ward	Belleville		B. & W.	B. & W.	Dbl. End	Sing. End	Sing. End	B. & W.	Gunboat	Normand
Name of Vessel	U. S. S. Cushing.				Shore	Shore		Zenith Cty	Shore.	Newark.	Iona.	Wheeling	Marietta	Concord	Proposed
Outside Dimensions	10' × 7' × 8				10'.3" d 11'.8" h	11' 6" × 8' 9" × 17'		14' 8" 12' 2" 8' 8"	15' 7" 10' 6" 8'	13' 6"d 19' 5" l	13' 3"d 10' 0" l	10' 6"d 10' 6" l	11' 7" 11' 7" 11' 5½	9' 9"d 17' 9" l	10' 12' 4" 18' 7"
Grate Surf sq. ft.	38				53	91.4		67	38.5	135	21	30	47	55	95
Heating " "	2451				2473.5	2900		3400	1552	4185	1580	1254	1832	2052	4650
H. S. ÷ G. S.	64.5				46.67	31.73		50.7	40.31	30.99	75.2	41.81	38.98	37.31	48.95
Wt. of Boiler, Empty, Tons.	9				11.84	36.00		31.85	17.78	57.80	29.30	25.91	23.24	30.19	36.87
" " Water "	2				2.01	2.00		7.41	4.21	22.32	17.87	10.94	4.02	14.99	9.12
" " Boiler and Water "	11				13.85	38.00		39.26	21.99	80.12	47.17	36.85	27.26	45.18	46.00
Duration of Trial, Hrs.	2.5	11.5	11.5	1.0	12	....	....	10	24	8	16	4	4	4	24
Air Press. Ins. of Water	0.0	0.5	3.0	4.0	2.0	a 6.3	a 8.0	nat. draft	0.9	2.25	0.2	0.78	0.36	2.3	......
Feed Temp. F°	52	58.5	58	52	50.04	42	42	118	58.5	......	106	104	121	140	......
Steam Press. ab. atmos. lbs.	250	250	250	250	160	260	260	195	156.3	125.5	165	182	174	164.3	220
Coal pr. hr. pr. sq. ft. G. S.	7.58	24.12	40.23	66.32	55.05	18	24	26.6	44.2	40	22.4	30.92	24.47	42.74	27.2
Refuse %	6.11	8.04	7.53	6.27	4.84	11.5	5.4	8.8	7.0	3.3	2.9	4.0	4.0	3.7	......
Moisture %	8.09	2.11	3.89	6.68	12.48	....	....	0.3	2.0	......	2.87	......	......	......	......
Evaporation per lb. Coal:															
App f temp feed a temp st'm	10.55	8.13	7.53	5.69	6.60	8.78	8.47	7.01	7.01	......	9.15	c 8.62	c 7.25	c 5.80	......
" f and a 212° F.	12.95	9.93	9.19	6.98	8.04	10.81	10.42	8.06	8.47	......	10.63	c 10.00	c 8.26	c 6.51	......
Actual f and a 212° F.	11.90	9.72	8.84	6.51	7.31	10.81	10.42	8.04	8.31	......	10.20	c 10.00	c 8.26	c 6.51	10.00
" " " 212° p sq. ft. Heating Surface	1.40	3.63	5.51	6.70	8.62	4.99	6.41	4.21	9.11	......	3.08	c 7.40	c 5.19	c 7.46	5.56
HP. p. 100 sq. ft. H. S. f & a 212°@ 18 lbs. st'm pr I HP	7.78	20.17	30.61	37.22	47.89	27.72	35.61	23.39	50.62	b 55.90	17.11	b 43.05	b 28.76	b 41.47	30.91
H. P. p. ton of boiler and water on same basis	17.33	44.93	68.20	82.95	85.53	21.15	27.18	20.26	35.73	b 29.20	5.73	b 14.65	b 19.33	b 18.84	31.25
Wt. boiler and water p. sq. of H. S. lbs.	10.05				12.55	29.35		25.57	31.7	42.88	66.88	65.82	33.33	49.31	22.16

a. Natural draft, air mixer. b. Actual trial trip. c. Estimate from coal per I. H. P. at 18 lbs. steam per I. H. P.

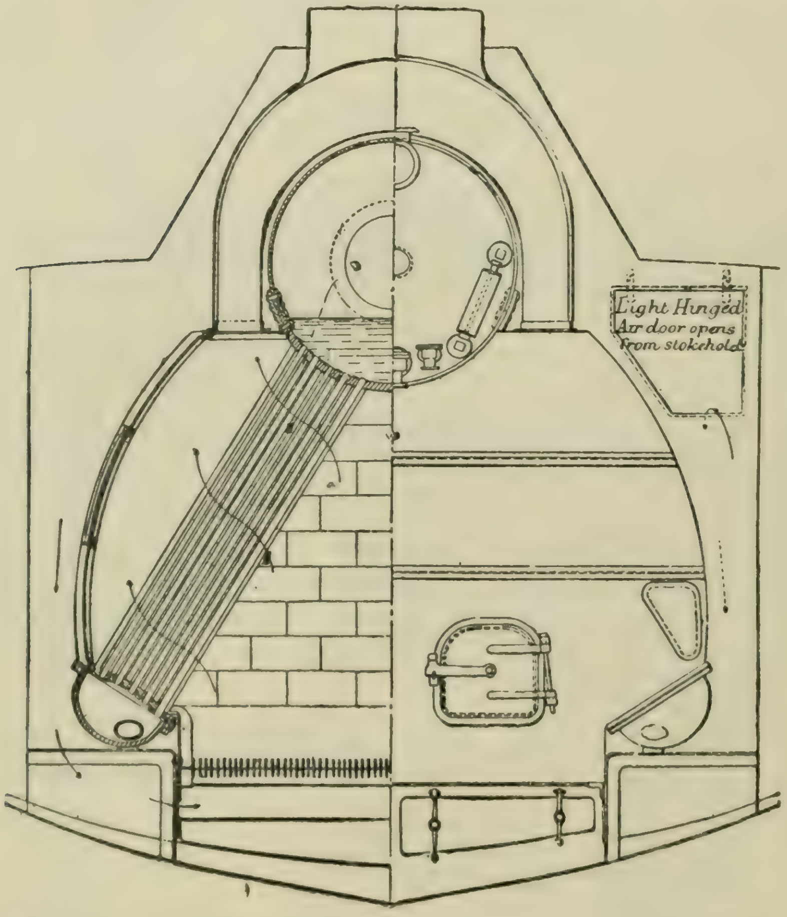


THE D'ALLEST WATER-TUBE BOILER.

Explosions less disastrous.—Of course, explosions are to be avoided entirely, but they do occur, and the small amount of water in the water-tube boiler assures a minimum of disaster. In 1895, while in the harbor of Kiel, a Ward launch boiler belonging to the U. S. S. San Francisco blew off the top of the steam dome. Nobody was hurt, and little damage done beyond the loss of the dome top, attached fittings, and boat awning. A new top was fitted at the Kiel dock yard, and the boiler afterwards did good service with forced draft.

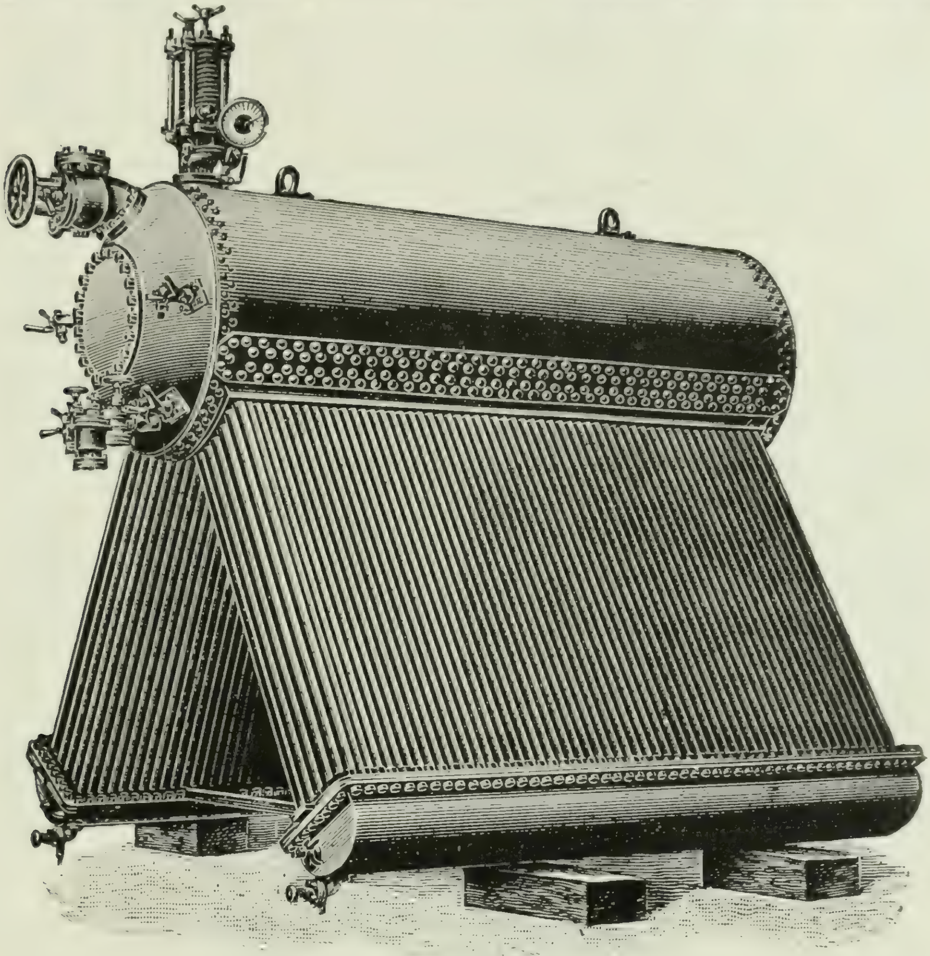
Shortly before this, a locomotive boiler in a torpedo boat built for Turkey had exploded in the harbor of Kiel, because of the collapse of a furnace crown, killing every man in and near the fire-room, and wrecking the boiler and the deck over it. The circumstances were, of course, different, one boiler being in an open boat and the other in a closed fire-room.

A recent case, described in *Engineering*, shows, however, that a small shell boiler, when it explodes, will do great damage. The account says: " * * * when a fearful explosion occurred, accompanied by a deafening report. Pieces of the vessel were blown in all directions, and Mr. Tyrrell and his son were lifted to a considerable height in the air and thrown into the middle of the river. The launch itself disappeared, and all that remained were floating pieces of the wreck. The boiler was thrown against a wall on the river bank, and pieces of wood and iron were hurled in all directions, while some wooden gates on the opposite bank were set on fire by the hot coal from the furnace." The boiler was 3 feet 6 inches long and about 2 feet 2 inches in diameter.



ELEVATION AND SECTION OF THE YARROW WATER-TUBE BOILER.

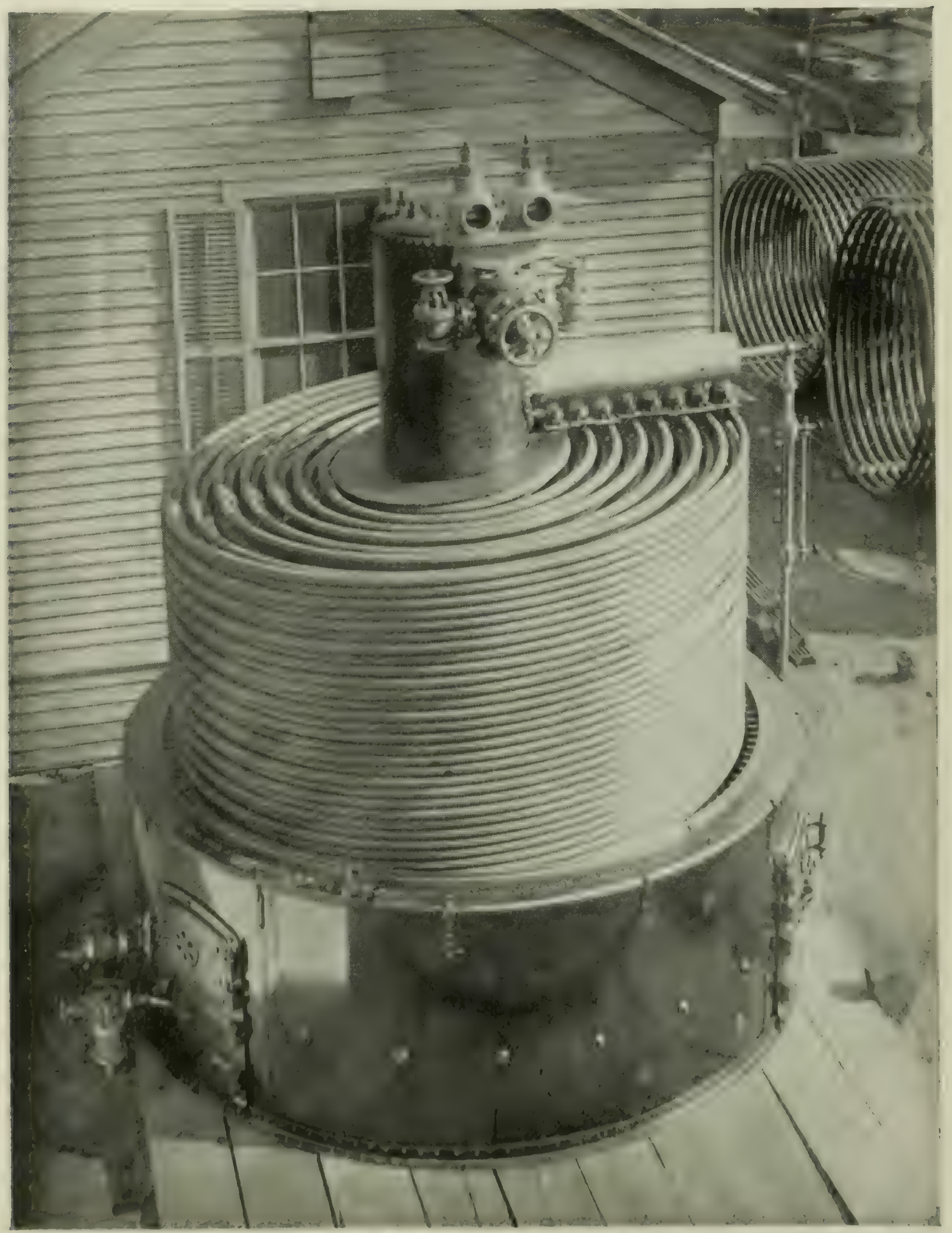
A very recent illustration of the less danger from the explosion of a water-tube boiler is that of the boiler of one of the steam launches of the U. S. S. Texas in October of this year. The entire steam dome was blown off. There were nearly forty people in the boat, some around the boiler. Several received slight injuries, and one was slightly scalded. Except for the loss of the awning, the boat was not damaged. Had it been a shell boiler, undoubtedly a number would have been killed.



THE YARROW WATER-TUBE BOILER.

The greatest loss of life from a water-tube-boiler accident was on the Jauréguiberry of the French navy, where a split tube caused a rush of steam and flame from the furnace fronts, resulting in the death of six men. There was, however, no wreckage, and the replacing of the defective tube and some overheated ones made the boiler as good as ever.

Ability to stand very high pressures.—This is evident from the design of the boiler, the greater part consisting of small tubes which can



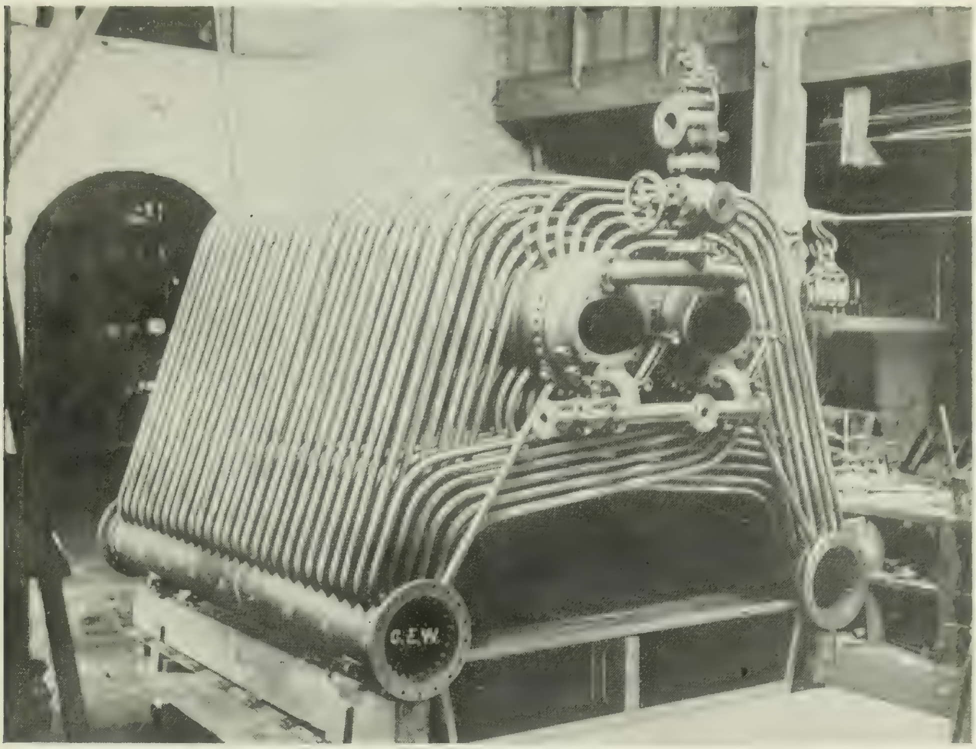
THE WARD WATER-TUBE BOILER.

As used on U. S. Coast-Defense Vessel "Monterey," U. S Revenue Cutters "Manhattan," "Hudson," "Calumet," etc.

readily be made strong enough to carry pressures far above anything thus far thought of. Even in boilers with flat water legs, adequate strength is readily secured. The boilers of the torpedo boat Cushing have been carrying 250 pounds since 1890, and nearly all of the United States torpedo boats are designed for that pressure. The Nashville, designed in 1893 (a gunboat of about 1,400 tons), also carries a pressure of 250 pounds in her Yarrow boilers.

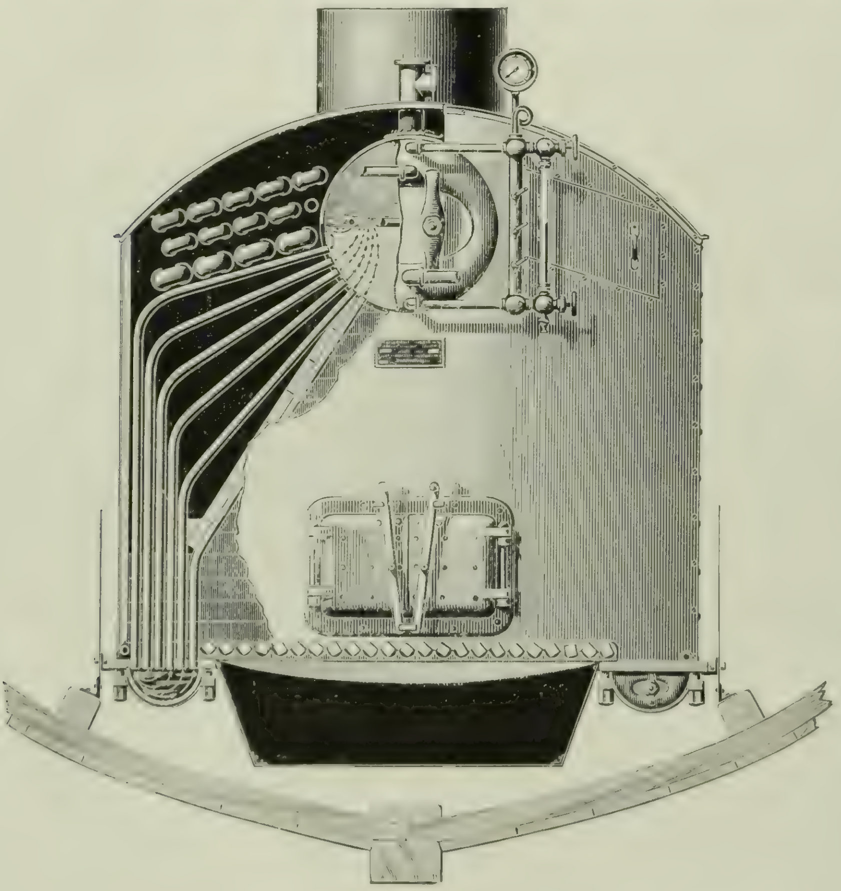
Sir John Durston, the eminent engineer-in-chief of the British navy, who has successfully fought so hard a fight in the introduction of water-tube boilers in that navy, is using even higher pressures, having adopted 300 pounds for the boilers of the Pelorus, which had her trials about a year ago. The boilers are the design of M. J. A. Normand, the famous French engineer and torpedo-boat builder. A sister ship, the Proserpine, has Thornycroft boilers for the same pressure.

Ability to stand hard forcing and rapid change of temperature.—Speaking generally, this is true to a great extent of all forms of water-tube boilers, and without limitation of those with small tubes. It is due almost entirely to the elastic structure of the water-tube boiler, which can accommodate itself to very high temperatures and to rapid changes of temperature. Just here it may be observed that, by general consent, there are two well-marked classes of water-tube boilers,—those with large and those with small tubes, the former being never less than four inches and the latter never more than two inches in diameter. This causes a marked distinction in detail. As the small tubes can be readily bent, they generally are, thus providing admirably for irregular expansion, and the facility of manufacture permits joining of cylindrical drums,—a very strong form. As it is practically impossible to bend the large tubes, they are always straight, and usually join flat water chests. The Belleville boiler secures a certain



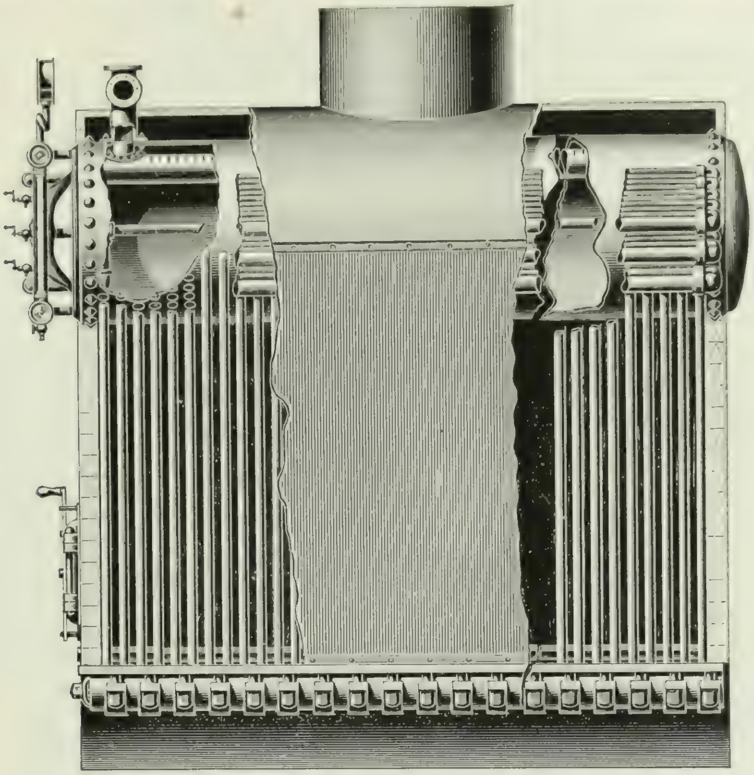
THE WARD TORPEDO-BOAT BOILER.

amount of flexibility by joining the tubes in a zigzag by means of return bends, but this has its disadvantages. In both forms, however, the flexibility is much greater than that of the very rigid cylindrical boiler, so that they can stand almost any amount of forcing without injury. Mr. C. D. Mosher, the well-known builder of the fast boats Norwood and Feiseen, gave an account at the International Engineering Congress (Chicago, 1893) of a test of one of his boilers with an air pressure of 12 inches of water, and an evaporation of more than 18 pounds of water per square foot of heating surface, which was accomplished without injuring the boiler. American naval steam launch boilers (which are all of the water-tube type) show how this type can stand rough "heat usage." The service they perform is very trying and irregular, but does not result in the leaks which would be sure to come from such treatment in a shell boiler.



FRONT VIEW.
THE SEABURY WATER-TUBE BOILER.

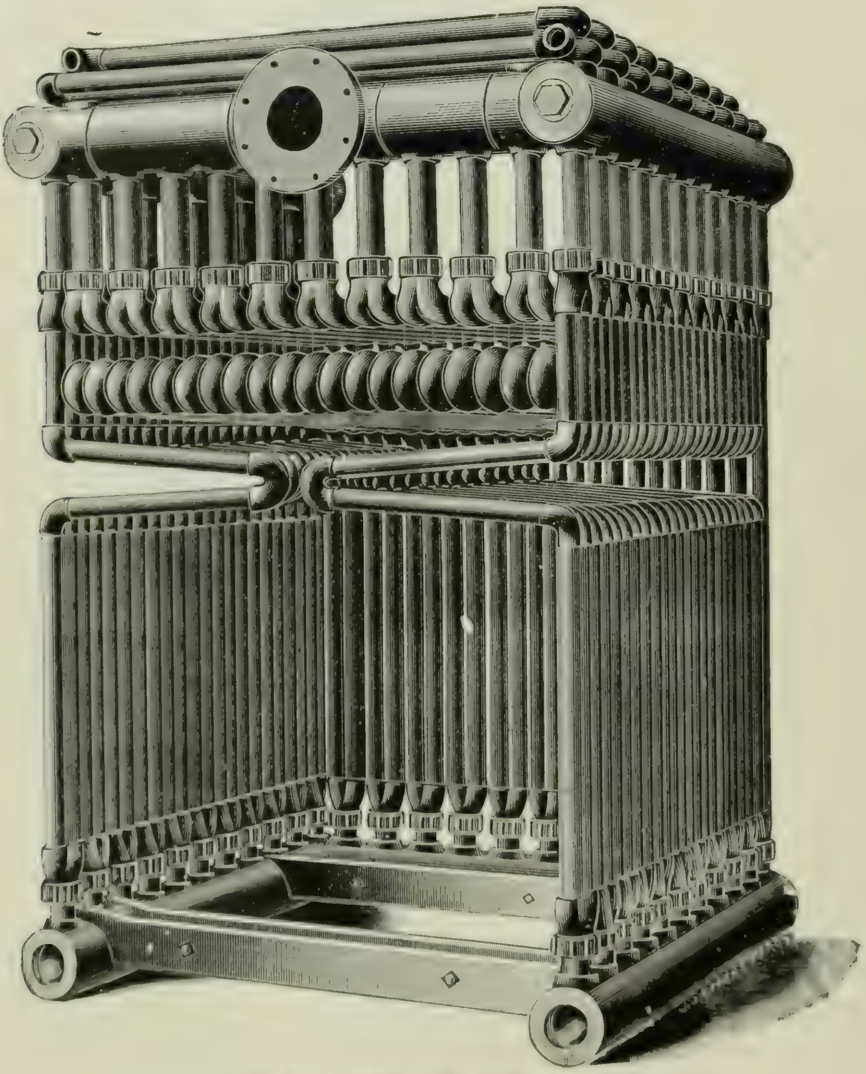
Rapidity of raising steam.—While not of much importance in merchant vessels, this is a point of great tactical advantage in war vessels. In time of war the ability to raise steam quickly is of vital moment. It is possible in water-tube boilers both on account of the small weight of water and structure and of the freedom from injury due to rapid changes of temperature. This, too, is true only in part for the large-tube boilers, but entirely so for those with small tubes. It is perfectly practicable in one of the latter to raise steam from cold water in half an hour or less, while the large cylindrical boilers, when well cared for, are allowed from six to twelve hours.



SIDE VIEW.
THE SEABURY WATER-TUBE BOILER.

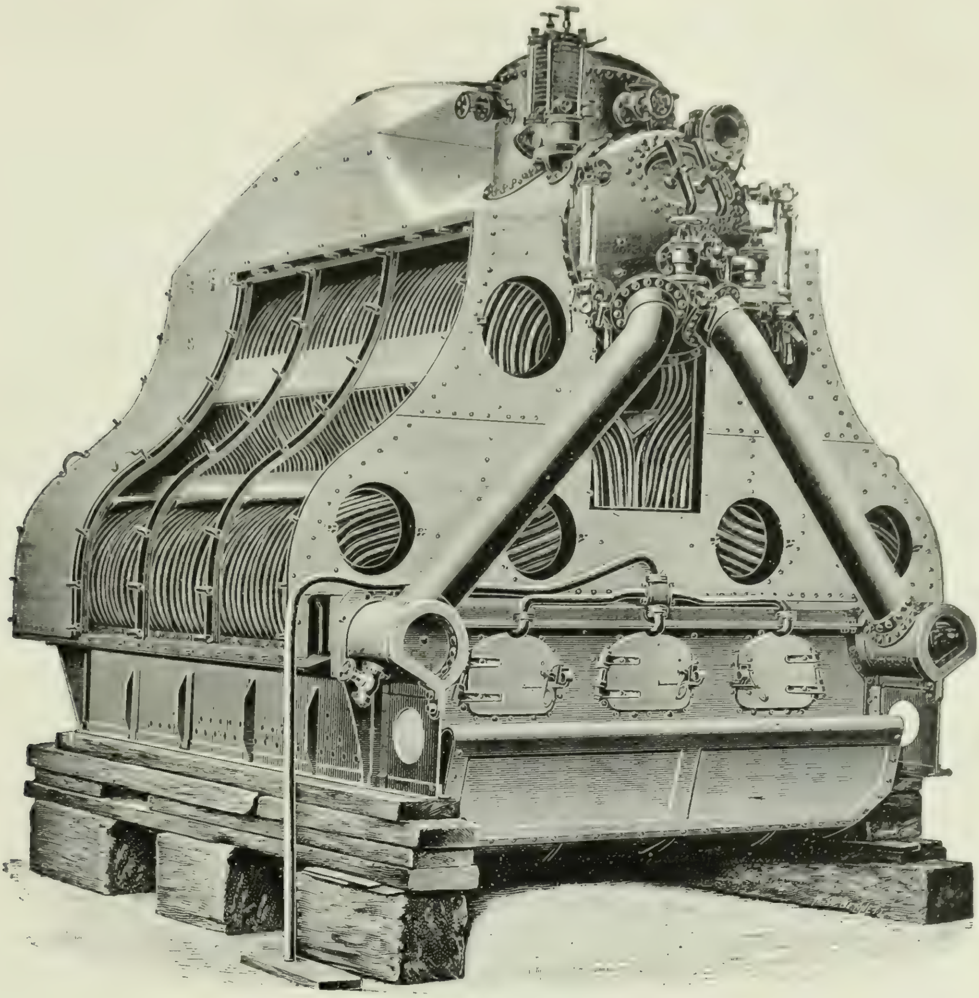
Facility of repair and renewal.—The principal repairs to a water-tube boiler are to the tubes themselves, when they become defective through corrosion. At first they are usually simply plugged, as the heating surface is generally so extensive that the laying off of a few tubes does not matter. When corrosion becomes general all the tubes are renewed; this is ordinarily not difficult, and can be done by the force on board ship, as was the case recently on the Monterey of the United States navy. If it becomes a question of renewing the whole boiler-plant, the water-tube type has great advantages, as the largest parts, the steam drums, are still small enough to pass through existing openings. On a war vessel, with a protective deck, this is an important item. The installation of a cylindrical boiler 15 feet in diameter and 20 feet long requires the removal of a part of the deck.

This list of advantages almost makes it appear that any one who does not promptly adopt the new type is unprogressive. There are, however, some disadvantages, which have caused conservative engineers to be a little slow in accepting water-tube boilers as a commercial success. They are, perhaps, ready to admit their superiority for war vessels and yachts, where the circumstances are peculiarly exacting, but they regard the shell boiler as an "old friend" not to be lightly abandoned.



THE ALMY WATER-TUBE BOILER.

First of all, the water-tube boiler does not lend itself readily to large power in a single boiler. There are probably hundreds of cylindrical boilers of 2,500 i. h. p. in use to-day, while there are very few water-tube boilers of 1,000 i. h. p., the vast majority having about 500. The Campania has twelve boilers for about 31,000 i. h. p., while the



THE REED WATER-TUBE BOILER.

As used on the British Torpedo-Boat Destroyer "Janus."

Powerful and Terrible each have forty-eight Belleville boilers for about 25,000 i. h. p. This great increase in the number of boilers means a proportionate increase in all fittings, with increased care in attendance. Col. Soliani, of the Italian naval engineers, very wittily expressed this at the Chicago Engineering Congress by saying: "It is easier to drive four big horses than twenty ponies."

The small amount of contained water, which is a great advantage in most respects, is a disadvantage as regards feeding the boilers and maintaining a steady steam pressure. Most builders of water-tube boilers now fit automatic feeding arrangements. Indeed, without them water-tending sometimes becomes, as was expressed by a friend of the writer who made a trip on one of our merchant steamers with a large battery of water-tube boilers, "a sprinting match." Passed Assistant Engineer Gage, U. S. N., in speaking of his experience on the Monterey, said: "There is no trouble in feeding a lot of water-tube boilers in battery, but every chump who calls himself a water tender can't do it."

One serious disadvantage is that a bad leak in a single tube necessitates the disuse of the boiler, as steam must be blown off and the boiler cooled enough to permit entrance and access to the tube ends for plugging. This makes it advisable to have the unit for water tube boilers small, and this, as we have seen, is compelled anyhow by structural reasons. In a fire-tube boiler, a leaky tube can be plugged without any change in the regimen of the boiler.

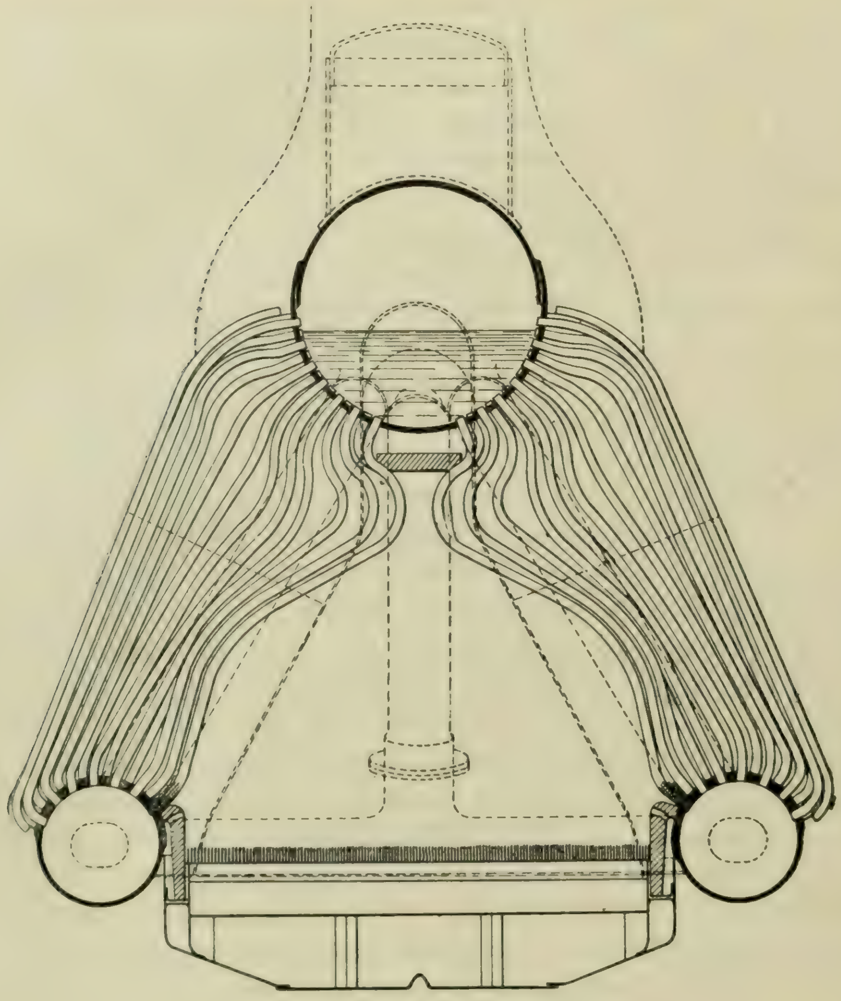
It is probable that a better quality of tubes is required for the new type. The accident on the Jauréguiberry was due to a defective lap; makers certainly prefer weldless tubes. For the small thin tubes of torpedo-boat boilers they are absolutely essential.

Many engineers believe, too, that water-tube boilers are not economical in evaporation. It is an undoubted fact that in a number of cases the uptake and chimney temperatures have been excessive, and the coal per i. h. p. (with economical engines) high. However, the figures in Table I. show excellent economy at all but the highest rate of combustion, as do those for the B. & W. Boiler in Table II., and it is safe to say that no ordinary cylindrical boiler would do any better, if as well. It must be remembered that, for high rates of combustion, Serve tubes and retarders have been fitted in the ordinary boiler. The writer believes this lack of economy, where it exists, to be due to two causes,—excessive forcing and too free a passage for the gases of combustion to the chimney. There has not yet been enough experience with all forms of water-tube boilers to enable their designers to secure the highest economy under severe forcing. Some of them are striving earnestly by systematic experiments to get this experience, but meanwhile the water-tube boiler is blamed because it does not do more than should be expected. Last summer the writer had the pleasure of visiting the works of Mr. Yarrow, known to all engineers as one of the most talented leaders of the profession, and whose famous experiments on circulation in water-tube boilers ended a long controversy, leaving the participants nothing to do but find an explanation. Notwithstanding the success of his boiler, he was still experimenting to secure economical evaporation at high rates of combustion, and had obtained very promising results. Yet some of his boilers, installed in this country, away from his own supervision, have not proved economical under severe forcing. This is not the fault of the boiler, but of the "baffling" devices for regulating the flow of the gases. Another case, where B. & W. boilers are concerned, has attracted a great deal of attention, but the lack of economy is undoubtedly due to excessive forcing, as it has transpired that boilers designed for less than 7,000 i. h. p. were forced nearly 2,000 i. h. p. beyond the design. This question of economy is not a matter inherent in the type of boiler, but is a detail of design which will undoubtedly be satisfactorily worked out as further experience is acquired.

Longevity, or durability in regular working, is the point that has probably caused more hesitation in the adoption of water-tube boilers than any other. The tubes of cylindrical boilers corrode, too, but, after all, they are only a part of the boiler, while in the new type they practically are the whole boiler. Moreover, as already shown, the occurrence of a few bad leaks in different boilers simultaneously might throw out of use a large part of the plant. In the United States navy the rapid corrosion of thin steel tubes in ordinary boilers had made it seem probable that the life of a water-tube boiler would not be more than three years, but investigation developed the fact that the integrity and efficiency of the boilers had been sacrificed to the smart appearance of the ship, the boilers being used as trimming tanks, in defiance of all experience and the laws of chemistry. This has been stopped, and the boiler tubes are now longer-lived. Corrosion, after all, is very largely a question of intelligent care, and, if tubes of good material and reasonable thickness are properly cared for, their longevity will be satisfactory. Twenty years ago we did not know how to preserve boilers, but ruined them in the belief that we were pursuing a correct course. We are better informed now, and do not make such mistakes.

In tubes of small diameter, especially those that are bent, it is difficult, if not impossible, to clean the interiors properly, so that the use of salt water and the presence of oil are inadmissible. However, good practice also taboos these for cylindrical boilers. It may be said, and with reason, that salt water will sometimes be unavoidable from a leaky condenser. Mr. Yarrow, with his usual sagacity, recognized this, and, in his usual way, put it to the test of experiment. He went much further than a simple leak, and practically fed from the sea, until the density was nearly five times that of ordinary sea water. The result, after an eight-hour run, was a very light coating of scale in places, which was easily removed. The test was repeated a number of times with the same result, showing that a slight leak in the condenser need cause no fear.

Space will not permit an extended historical notice of the water-tube boiler for marine purposes. It appears that it was used as far back as 1857, but the early efforts failed for various reasons. Mr. Charles Ward, the designer and builder of the water-tube boilers of



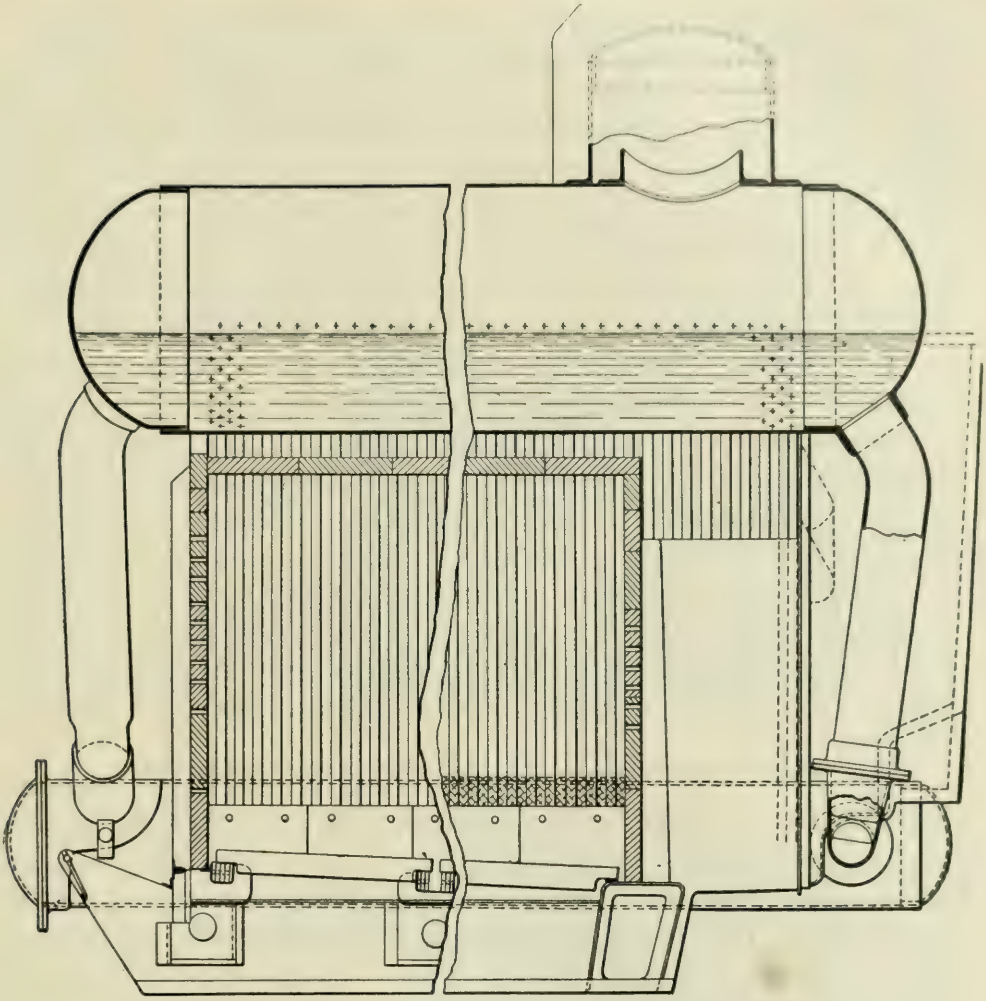
CROSS SECTION.

THE NORMAND WATER-TUBE BOILER.

As used on the French Torpedo-Boat "Forban," and on H. M. Torpedo-Boat Destroyers, "Surly," "Shark," "Rocket," etc.

the Monterey and of most of the steam launch boilers in the United States navy, places the renaissance of the water-tube boiler for ships about twenty years ago, when Herreshoff, Loftus Perkins, Thornycroft, Belleville, and himself were all working at the problem. The Voltigeur, of the French navy, had Belleville boilers installed in 1879, and they were gradually placed in other vessels. Other types were also tried, and now cylindrical boilers are no longer used in new designs. For some time only large-tube boilers were used in large ships, but the triple-screw cruiser Jeanne d' Arc, of 11,000 tons and 28,000 i. h. p., is to have Normand (small-tube) boilers.

The use of water-tube boilers in torpedo boats began when Mr. Thornycroft, another talented engineer, built the Ariete for the



LONGITUDINAL SECTION.
THE NORMAND WATER-TUBE BOILER.

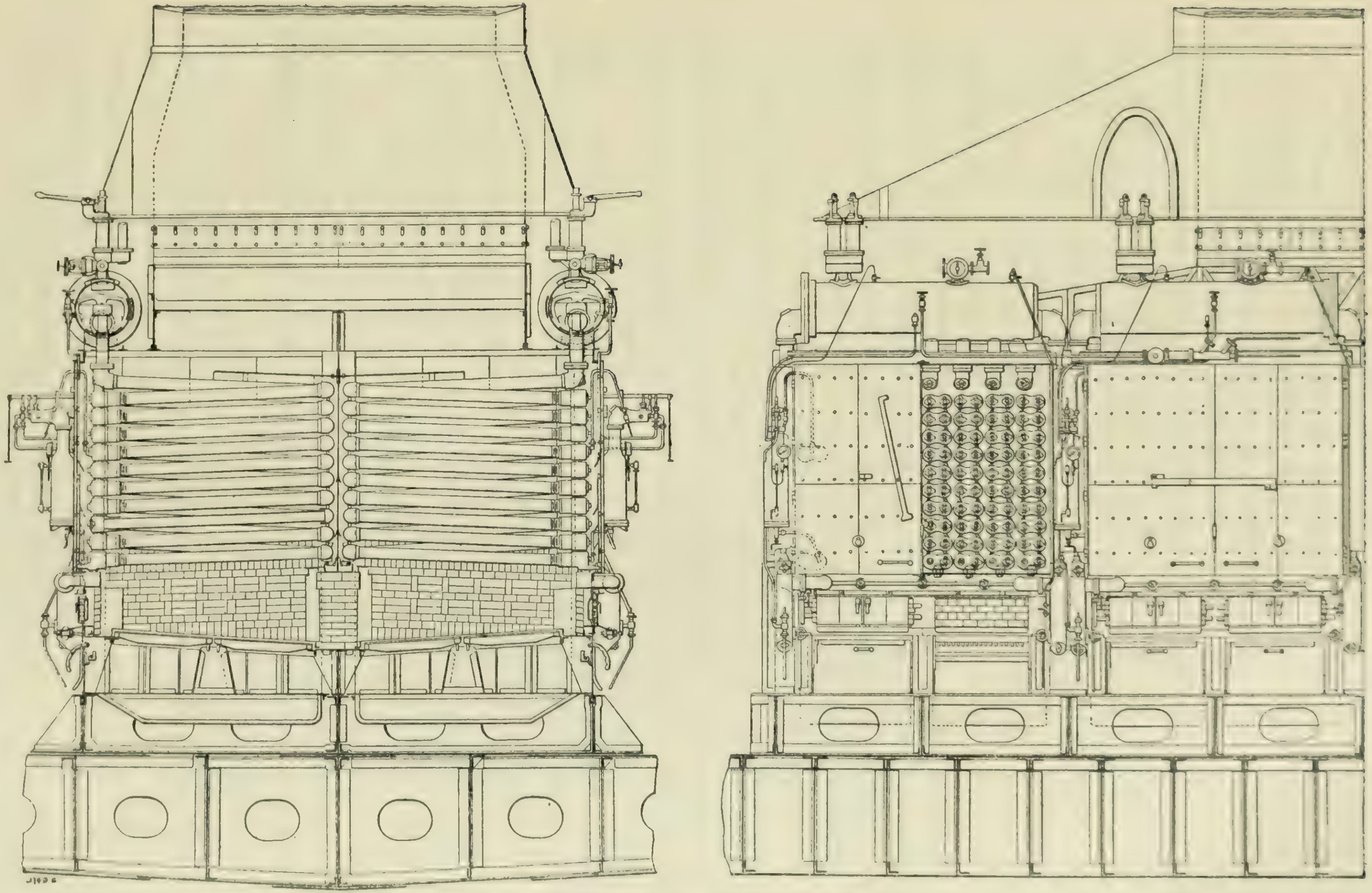
As used on the French Torpedo-Boat "Forban," and on H. M. Torpedo-Boat Destroyers, "Surly," "Shark," "Rocket," etc.

Spanish navy in 1887. In the intervening ten years the small-tube form of the new type has taken possession of the field, although a few designers who had made a great success of the marine locomotive boiler clung to it desperately, and one, as late as December, 1892, attempted to show that it was as light and efficient as the water-tube. In the United States navy, although it has had only a few vessels of this class until now, they have all had water-tube boilers, beginning with the Herreshoff boats Lightning and Stiletto, the latter being afterward provided with an Almy boiler.

The British navy promptly took hold of the small-tube boilers for torpedo boats, and in 1893 eight Thornycroft boilers were fitted in the Speedy, a gunboat of about 800 tons. In that year also, Belleville boilers were ordered for the Sharpshooter, which has since served as a training-school for stokers and as an experimental ship for Belleville boilers. Sir John Durston had made up his mind to use water-tube boilers, but he had a hard fight, and it is safe to say that he staked his professional reputation on the success of the Belleville boilers of the Powerful and Terrible. He had sent officers to make long trips on merchant steamers fitted with these boilers, had tried them in the Sharpshooter, and was satisfied they would be successful. Many able engineers do not share his opinion that this is the best of the water-tube boilers ; indeed, many regard it as ranking low, but Sir John probably had in his mind that the great argument against water-tube boilers would be that they had not been in use long enough to warrant their adoption. To this objection only the Belleville boiler could answer, as it had been in use in the steamers of the Messageries Maritimes since about 1885, and has been fitted in each new steamer they have built. Consequently he could make a better fight for this boiler than any other. Although beginning the use of water-tube boilers on the large ships so recently (the Powerful and Terrible were tried only about a year ago), the British navy has adopted them entirely, and all the new vessels now building are to be supplied with them.

In the United States navy the present engineer-in-chief, Commodore Melville, with characteristic energy, took up this subject as soon as he was appointed in 1887, and in a very short time all the steam launches were fitted with water-tube boilers. A few had had Herreshoff boilers of the old type, which had not given entire satisfaction, although possessing some good features. (It may be mentioned, in passing, that the United States navy is the only one which uses water-tube boilers exclusively for steam launches.) In 1888 he induced the navy department to invite a competitive test among makers of water-tube boilers in the United States, with a view to their use in naval vessels. The tests took place in 1889 and 1890, and, as a result, four Ward boilers of an aggregate i. h. p. of about 4,500 were ordered for the Monterey. The vessel was tried in January, 1893, and has been in commission ever since, the boilers giving entire satisfaction. This was the first instance of as great a power as this in water-tube boilers in a large vessel. Since then Babcock & Wilcox boilers have been fitted in the Marietta and the Annapolis, and Yarrow boilers in the Nashville. B. & W. boilers are building for the Chicago and the Atlanta.

It is perhaps, at a hasty glance, a source of surprise that, having started the use of water-tube boilers on large ships nearly ten years ago, Commodore Melville should not have pushed their introduction as new ships have been designed. His position has been rather



THE BELLEVILLE WATER-TUBE BOILER.

As used on the Russian Volunteer Steamer "Kherson," also on the British Cruisers "Powerful" and "Terrible," etc., etc.

embarrassing. Convinced personally of the success and reliability of the water-tube boiler, and realizing the *éclat* he could so easily gain by being thoroughly "progressive," he yet felt that he would be risking too much for the new fleet in filling it with boilers about whose durability there might be a question. The Monterey is a coast-defence vessel, and would always be within easy reach of repair shops, so that, had there been trouble with her boilers, it could have been quickly remedied. One object in fitting water-tube boilers in her was to test, by practical use on a large vessel in regular cruising, their durability and general qualities. To reduce weight is a good thing, but to have thoroughly reliable boilers is better, and the saving of some tons of weight would have been dearly bought if it involved the laying up of a battle-ship when the nation had only three afloat. The two great powers which have made the change were simply adding to already powerful fleets; the United States were creating theirs from nothing. Now that they have a respectable fleet, and experience has been gained with water-tube boilers that insures their reliability, Commodore Melville has decided to use them entirely, as shown by his last annual report, recently published.

In the merchant marine, water-tube boilers have not been used to anything like the extent they have in navies; indeed, it is not much of an exaggeration to say that they are hardly used at all in the merchant service, except in France and the United States. Russia has at least one example in the Kherson, of about 13,000 i. h. p., and there are a few English vessels of small powers. It is exceedingly difficult to give figures for the aggregate horse power of the water-tube boilers in the merchant service of different countries (including yachts) without an amount of research entirely disproportionate to the result sought, but round numbers about as follows are probably not greatly wrong: France, 80,000 i. h. p.; United States, 140,000 i. h. p. There are three United States vessels having more than 7,000 i. h. p. each of water-tube boilers.

Boilers of this type have been in use in the United States since 1878, and a number of boilers have lived more than twelve years, some of them in sea-going vessels.

The delay in introducing water-tube boilers in the merchant service, as compared with their naval use, is exactly the reverse of the experience with multiple-expansion engines. In the latter case the merchant service was in the lead by several years. The reason for the difference is probably largely due to the different requirements of the two services. In the naval vessels, anything that will reduce weight is eagerly welcomed, regardless (within reason) of economy. In the merchant steamer, economy is the first consideration, almost regardless of weight. Consequently, as the chief advantage claimed for water-tube boilers was reduction of weights, it did not appeal to the commercial world as it did to the naval designer. Again, nearly all navies had had trouble with shell boilers, due to excessive forcing in the effort to keep down weights, and the water-tube boiler gave relief from this evil. The boilers of merchant steamers were never forced very hard ; so this advantage of the new type was not so attractive for them. There is little doubt, too, that the great majority of builders of boilers for merchant steamers have felt that the shell boiler, when properly managed and cared for, was entirely satisfactory, and that there was no special object in using a type of boiler which has its disadvantages, and which would render useless a valuable portion of their plant.

As yet, there is certainly no agreement on any existing water-tube boiler as the best. Nearly every designer of ability thinks he can improve on what he considers the best existing boiler, with the result of very numerous patents. Where so many eminent men disagree, it would be unbecoming in lesser lights to indulge in prediction, but the writer believes it worth while to call attention to one aspect of the case. If the full benefit of water-tube boilers is to be obtained, it seems almost certain that they must be of the small-tube variety. As already shown, they possess all the merits of the new type (which is not true of the large-tube boilers), and the disadvantages are almost entirely such as are common to all boilers. Some years ago Chief Engineer Frank H. Bailey, U.S.N., one of the ablest American naval engineers, expressed the opinion that the "boiler of the future" would be of the small-tube variety, but with scantlings increased so as to insure longevity, increasing the weight per square foot of heating surface from 11 or 12 pounds, as in torpedo boats, to from 18 to 20 pounds. At the International Congress of Naval Architects and Marine Engineers in London, in July of this year, M. P. Sigaudy, the manager of the Forges et Chantiers de la Méditerranée at Havre, and the colleague of M. Normand in the Normand-Sigaudy boiler, read a paper giving designs for boilers of 23,000 i. h. p. for a transatlantic express steamer, in which he takes the view previously expressed by Chief Engineer Bailey. The last column of Table II gives some data of one of the boilers he proposes to use.

Finally, the prospect is that, in time, the water-tube boiler will be practically the only one used on shipboard. Even in the merchant service, weight is too valuable to be needlessly sacrificed. Evolution does not work backwards. Admitting that there are defects in the water-tube boiler, experience and intelligence will remedy them, as they have always perfected whatever was correct in principle.

THE TALL BUILDING FROM AN AMERICAN POINT OF VIEW.

A REJOINDER TO S. H. CAPPER.

By A. D. F. Hamlin.

THE wise man welcomes new views of matters which he has been accustomed to consider chiefly from a single standpoint. It is a good thing sometimes to be withdrawn from our environment and compelled to face the problems of our time from a different point of view,—to see ourselves and our doings, indeed, as others see us and them. This is as true of our American architecture as of any other interest ; the changing conditions of a rapidly-maturing civilization create new problems every year, for whose solution we need all the light and wisdom that we can get. We are trying to solve these problems according to our lights ; not always well, not always wisely, but in our own way, unhampered by tradition, and unassisted by example. It is a salutary thing to have the results reviewed from the European point of view. For, although the European can not be expected to enter fully into our situation, he can for that very reason the better point out failings of which we are only half conscious, or to which we have been wholly blind, and give us encouragement where we may have failed to appreciate our real successes. Cases of the latter sort are few, I fancy.

Prof. Capper, in his interesting paper in the November issue of this magazine, gives us the impressions of a cultivated English architect on the architecture of our tall buildings, particularly those of New York. Whatever may be thought by American critics, it is evident that to the European the American "sky-scraper" represents a most important contribution to architecture, and that our struggles with that intractable problem have attracted more attention in Europe than anything else we have done. This is not surprising, for our "sky-scrapers" are exceedingly *voyants* affairs, and exceedingly American. I question whether American architects generally look upon them in the same way ; but otherwise the American point of view appears to be substantially identical with that presented by Prof. Capper. Leaving aside a few minor criticisms and opinions, the main body of his paper expresses very fairly considerations and conditions which our own architects have more or less clearly recognized and struggled with, ever since the tall building began to rear its self-asserting and ungainly form in our cities. In presenting the

American points of view, therefore, I seek to blow no counterblast to Prof. Capper's critique, but rather to endorse and expand much that he has said briefly and concisely.

In the tall building it is emphatically "a condition, not a theory," that confronts us. The many-storied office-building is a necessary product of certain economic factors which have operated in spite of the architects, and more intensely in the United States than elsewhere. This is what has made it so peculiarly an American product. Of these economic factors the cost of land, so commonly alleged as the controlling one, has really been the least important. Land in parts of Paris and London is as costly as in New York and Chicago, but the fifteen-story office-building has never come into vogue there, while, on the other hand, buildings of ten or twelve stories are not uncommon in American cities of the second and third rank, where land is relatively cheap. The *causa causans* of the sky-scraping monstrosity is to be sought in the drive and hurry of American business life, and in the accompanying American propensity to save time and labor. The "sky-scraper" is a huge labor-saving and time-saving device. Not only does it make possible the concentration within a small geographical area of an amount and variety of business which otherwise would be spread over five or six times the same extent of territory, but it gathers into a single edifice an extraordinary number of activities, which otherwise would be widely separated. Each building is almost a complete city, often comprising within its walls banks and insurance offices, post office and telegraph office, business exchanges, restaurants, club-rooms, and shops. The business man can provide himself with clothes, shoes, cigars, stationery, and baths; receive and dispatch his mail and his telegrams; speculate on 'change; consult his lawyer and his architect in their offices; and transact his own business,—all without leaving the building in which his office is located. The express elevator which shoots him up to the sixteenth story or drops him with breathless speed to the basement is a product of this same American haste and economy, and without the elevator the tall office-building would be an impossibility. It is the triumphant success of the "sky-scraper" as a time-saving invention which has made it so conspicuous and insistent an element in our American architecture.

It is open to question whether the mere love of tallness has had much to do with the development of this convenient and necessary architectural nuisance. Increased height has, I imagine, usually been sought after, both in New York and Chicago, as a means for securing larger returns upon the capital invested in land, rather than to gratify the love for big things *per se*. Still, there is no reason to deny that the desire to outdo has had a perceptible influence in developing the architecture of the "sky-scraper"; not the mere love of tallness, but the ambition to surpass in achievement. The Washington monument is not, I think, a pertinent matter in this discussion. It was conceived before the tall office-building had come into being, and it is not generally regarded as in any sense a work of architecture. But it certainly is in our blood to admire scale, vastness, bigness, even of mere dimension, and to seek to outdo in these qualities in much of what we undertake.

This propensity we may indulge to excess, but we have no monopoly of it. It is present in all great and enterprising peoples. It has been at the bottom of our extraordinary material advance in the past twenty-five or thirty years. But it has also inspired the great achievements of other nations and times. The White Star Line is now building a steamship to beat the Kaiser Wilhelm der Grösse, which was built to beat the Great Eastern, which was built thirty-eight years ago in England to be the biggest ship afloat. The present basilica of St. Peter at Rome was built to be the biggest church on earth, and was conceived in the first place by Pope Julius II to serve as a mausoleum for the biggest tomb on earth—a purpose which was never realized. Amiens cathedral was planned to be the biggest and "tallest" cathedral in France. Later the diocese of Beauvais tried to build a bigger one yet, with a taller vault. They came to grief, but the choir of Beauvais is still the tallest and broadest choir in France. Cologne cathedral was designed to be the biggest cathedral in northern Europe, and its twin spires to be the tallest and biggest. Prof. Capper himself cites the ancient Egyptians and the ambition of Queen Hatasu, or Hat-shep-sut, to erect the tallest obelisk: "they vied eagerly in the size of these noble blocks." The ambition to surpass in mere dimensions has given rise to some of the most impressive architectural monuments in the world. It is to be deprecated in works of art only when it is unaccompanied by artistic taste and judgment, as was the case with the Washington shaft. That this is not always the case with us I think the Columbian Exposition may be adduced to prove. As to the city hall at Philadelphia, most American architects prefer to change the subject when it it is mentioned. It is not quite fair to compare its tower with the spires of Cologne or Burgos or Strasburg. American architects have done some creditable work in tower-building. The spires of St. Patrick's cathedral in New York are not as tall as the Washington monument or the Philadelphia Penn-capped tower; but they are lofty, and they are beautiful. And there are others.

Mere height without art is not in itself admirable; certainly our

Anglo-Canadian friend is right in this. It is not the height of our office-buildings that we admire. Indeed, we may almost say that from the purely artistic point of view they do not satisfy us at all.

They are, it is true, admirable as works of engineering design and construction. American inventiveness and mechanical skill have achieved in them a genuine triumph. There is no class of modern structures, on the whole, better built, better equipped, better arranged, better furnished, than the great office-buildings of New York, Chicago, Boston, and Philadelphia. From the practical and utilitarian point of view they represent a very high degree of successful achievement. But to the eye of the architect they certainly do not appear as works of preëminent artistic merit. Some of the reasons for their failure as architectural compositions the article already referred to clearly recognizes. An immensely tall edifice, which has the proportions, in one direction at least, of a tower, but which cannot logically be treated as such; which must be perforated by almost countless small windows, and be divided into the greatest possible number of stories; whose ground story must consist of stores with huge plate-glass fronts, and upon whose flanks, abutting on party-walls, architectural projections of any sort are forbidden; a vast edifice without a single heavy pier, and in which effective contrasts of voids and solids are generally impossible; an edifice, moreover, in which practical and financial considerations must of necessity dominate, leaving to artistic invention the narrowest possible margin for its exercise,—such is the problem which American architects have had presented them for solution. That they have not yet succeeded in making of this intractable monstrosity a temple of beauty is not to be wondered at. Even Mother Nature, in framing the elephant, the whale, and the giraffe, has not produced the acme of grace and attractiveness, to human eyes at least, though these three colossal designs of hers are no doubt admirably adapted to their purpose and function from the practical point of view.

The practical and structural aspects of the problem have, as I have said, and as is generally conceded on both sides of the Atlantic, been handled by our architects with commendable skill and ingenuity. The engineering questions and difficulties in these buildings are so important that an entirely new and very interesting relationship has grown up between architecture and engineering. While it is true that the problems of deep foundations and of steel-frame construction have been chiefly worked out by professional civil engineers, it is equally true that these men have labored side by side with the architects, often in business partnership with them, and that each side of the partnership has profited greatly by association with the other, and learned much from it. The engineers have become specialists in the architectural phase of their profession, while, on the other hand, the architects have been compelled to master at least the general principles of engineering construction. This intimate association of the two professions, so long distinct and almost hostile, is a fact of deep import and full of promise for American architecture. One glory of Gothic architecture is precisely that intimate union of scientific construction with artistic design which made of Amiens, for instance, so consummate a piece of engineering as well as so noble a work of pure architecture. In the Middle Ages structural problems were solved empirically ; it took two hundred years to learn how to build an Amiens. Each builder solved a problem identical with that of his predecessors, but tried to do it better. Thus the amount of novel engineering calculation or study required for each new masterpiece, and the amount of novel artistic invention in the design, were alike reduced to a minimum. The work was carried on slowly and cautiously, with all the advantage of accumulated experience. With us, ten years have sufficed to create entirely new problems both of construction and design. Every year brings out new demands and new inventions. The engineering of a tall office-building is vastly more difficult and complex than that of any cathedral, and never repeats itself. The whole structure must be designed and built in eighteen months or two years. No " master builder " of the Middle Ages, no Abbot Suger, no William of Wykeham, would have sufficed for the task. It is the association of the engineering expert and artist-architect that has made even a tolerable solution possible. The interesting, the suggestive, the hopeful fact is that this has become no mere juxtaposition, but a really intimate and consentient partnership, and that, as a result, not merely in tall office-buildings in the United States, but in our American architecture generally, good planning and exterior design have become, and are becoming, more closely associated with first rate construction. In this we have in the past been wofully behind European practice ; it is a question whether we have not now overtaken it. Any one who remembers how American buildings were commonly put together twenty years ago will recognize the improvement. The importance of this side of the profession Columbia recognizes, by offering to its fourth-year students in architecture an alternative course in architecural engineering, and by emphasizing the structural applications of mathematics, physics, and chemistry in the three preceding years of the course. If the tall office-building is to be considered as the chief contribution of American architects to their art, I believe its real importance lies in the considerations I have just advanced.

As for the artistic qualities of this contribution, it may be frankly admitted that we have by no means satisfactorily solved the problem of exterior design. Many difficulties, defects, and failures are plain to our consciousness, besides those so clearly pointed out by Prof. Capper. The suggestions he makes are interesting, and quite in the line with American experience. They have all been tried, though it is very likely that they have not all been rightly or sufficiently tried. With regard to two of them there is likely to be considerable difference of opinion. Whether it is or is not desirable to emphasize the vertical element instead of the horizontal cannot be settled by any off-hand and sweeping rule. The multiplied reiteration of the horizontal line in the St. Paul building, for instance, can hardly be regarded as a thoroughly successful treatment. To accord a certain amount of importance to the vertical elements in a lofty building certainly seems reasonable ; to suppress them altogether in favor of accented horizontal lines is to make a vain effort to deny the undeniable fact of height. It renders ineffective the one impressive dimension of the building, and emphasizes with tiresome repetition the littleness of the component stories. Not so have those lofty towers and domes of Europe been designed. In all of these one notes a wise balance and combination of vertical and horizontal elements. The existence of stories is not dissembled or forgotten ; but neither is there any effort to deny the elements of height.

It is very true that an office-building can rarely be treated like a tower. The breadth or depth of its flanks in most cases forbids this. Otherwise there is no valid reason against such treatment. If the ground plan is square or only slightly oblong, and the height four times the frontage or more, the building becomes *ipso facto*, a tower, —not, it is true, a campanile or spire, but none the less a tower. Why not treat it as such ? In other words, why not distribute the voids and solids, reënforce the angles, proportion the horizontal divisions, and profile the crowning features, so far as possible, upon the principles which have produced satisfactory results in tower design ? The difficulties in the way are practical, not theoretical ; and the chief one is the necessity of sprinkling the whole body of the tower with peep-hole windows. All the more is it desirable, some will certainly argue, to mask and minimize this monotony of equal perforations by grouping them within strong architectural lines, mainly vertical, in order to give scale and dignity to the composition ; and this is precisely what is sought in a tower, and what many of our architects have sought to do in their office-buildings.

This involves the second point in which the European view may raise discussion, the treatment of the openings. It is readily granted that multiplied repetition of an architectural feature is one of the surest means to the end of impressiveness. The Colosseum is justly cited in support of this proposition ; the long vistas of English cathedrals furnish another illustration. But the feature thus repeated must possess intrinsic dignity or artistic value ; it must have *scale*. This is precisely what office windows do not and cannot possess. The office-floors average ten or eleven feet clear in height ; window sashes more than four feet wide are awkward to handle. These are not heroic dimensions. The bays at the Colosseum average twenty feet on centers and thirty to forty feet in height ; its four stories equal the height of an ordinary ten- or twelve-story office-building. The front of the Pitti Palace at Florence is most impressive with a vast number of windows all exactly alike, but they are colossal. The three stories of the palace are each nearly forty feet high. How to make two hundred to three hundred windows 4 × 8 feet each (or thereabout) into an impressive composition is really the *crux* of tall-office-building designing.

In Chicago, where so many of the structural difficulties of the problem were first worked out, the utilitarian requirements as to voids and solids have been most frankly accepted. There is, as a rule, less effort there than in New York to devise a distinctively architectural, or even artistic, frame for these countless openings. There is a certain boldness in this frank acceptance of conditions which is not without merit. And yet the result is not artistically pleasing, and the procedure can never lead to highly artistic success, because it is really a surrender to the difficulty, not a triumphing over it. Moreover, the Chicago examples have the advantage generally of greater breadth and mass than those in New York, among which there are but few that cover very large areas,—the Mills, Washington, and Bowling Green Buildings, and the Produce Exchange, among them.

That the New York examples, in which a more architectural membering of parts is sought after, are by no means ideally successful is admitted. Some of them err by too great insistence on vertical lines; some by a confusion of horizontal and vertical elements ; some by a too complete negation of the vertical. But in the best among them certain principles appear to be gradually crystallizing into practice. The horizontal divisions are so managed as to give a distinct pedestal, shaft, and capital, or crown. The base, made as solid and vigorous as circumstances will permit, is adorned with details of great richness, to catch the eye of the passer on the street. The shaft is sometimes very plain, with uniform windows uniformly spaced ; more often divided by strong piers or pilasters separating grouped windows, forming a species of colossal flutings. Usually the corners are treated like broad piers, pierced with as few windows as possible, to give strength to the composition. At the top, two, three, or four stories, contained between a strong band or architrave below and a vigorous crowning cornice, are treated as a capital to the design, with great richness of architectural light and shade, the decorative features being moulded on a large scale to suit their great distance from the eye. In some cases, the skyline is diversified by turrets and steep roofs ; more often a decorative *chêneau,* or balustrade, serves as a cresting above the cornice. The great difficulty in this aerial architecture is the question of scale ; it cannot be treated so as to be equally satisfactory in its relation to the whole huge building and to its small component parts. And it is true that the problem of the crowning cornice has not yet received its final solution.

In matters of detail, internal and external, there is more to commend. Sculptors, decorators, mosaic workers, and architects have in many cases wrought in close and harmonious association to beautify those parts of these buildings which are most in view. I believe there are few, if any, cities where the fine arts, the decorative industrial arts, and the art of architecture are practised in closer alliance than in New York, or where the relations between their practitioners are more wholesome and agreeable. In time they may together work out a worthy solution even of the complex and stubborn problem of the tall office-building.

MODERN WHARF IMPROVEMENTS AND HARBOR FACILITIES.

By Foster Crowell.

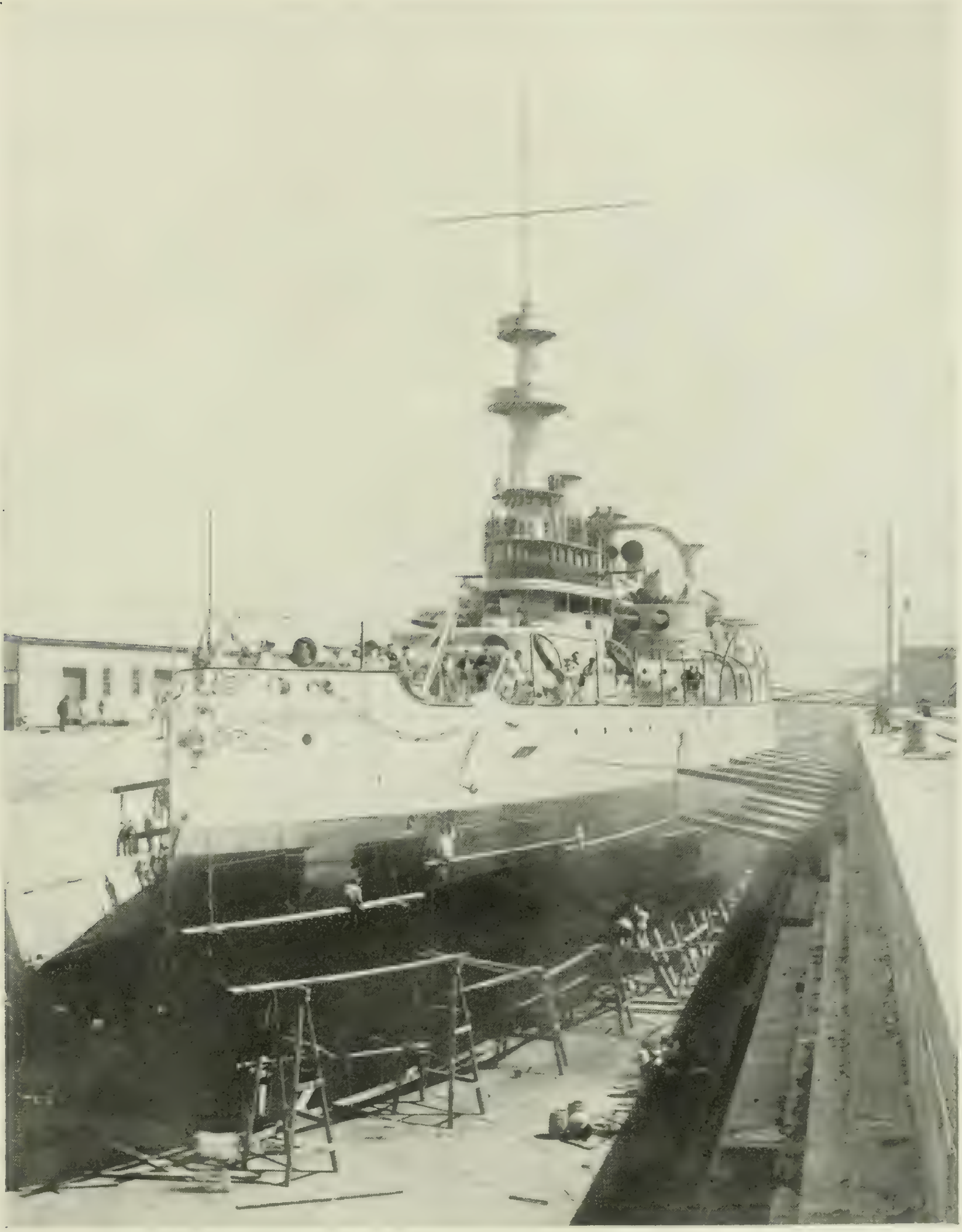
III.—THE DEPENDENCE OF SHIPPING UPON GRAVING AND REPAIR DOCKS.

WHEN it had become absolutely necessary, recently, to dock the United States battle-ship "Indiana," for cleaning and painting, Uncle Sam was obliged to send her to Halifax, Nova Scotia, and make use of the British dry-dock there. We can imagine that, before taking this step, some traces of the moisture of mortification may have been visible in his near sighted, national eyes as he recalled the vigorous twists he had just been imparting to the lion's tail, and other twists yet to be given as soon as he could get his ship cleaned and safely home again. But it is also to be inferred that no actual tears were shed, and that he will go on borrowing such facilities until his naval engineers give him "sure enough" dry-docks, as Uncle Remus would say. In view of certain notorious developments regarding several of the more recent efforts of the navy in this direction, it would be cruel to dwell on the subject, and perhaps somewhat misleading, because some of the larger United States vessels have actually been docked at home; in fact, one of the illustrations of this paper shows the "Iowa" in dock at the Brooklyn navy yard.

Neither is it necessary to enlarge upon it, the whole story being contained in two lines; the navy builds dry-docks, but the "Indiana" had to go all the way to Halifax simply to be cleaned.

It will probably be said that there was nothing unusual in this; that it is customary for ships of war of all nations to avail themselves of the nearest suitable dock of a friendly power,—which is, of course, true; but that does not alter the fact that a nation which possesses no adequate facilities of its own for keeping its war vessels in constant condition for service is at a perpetual disadvantage, on economic grounds in time of peace, and in much graver respects whenever the navy is needed in dealing with foreign complications.

Since the above lines were written, a very high authority in naval matters, the Chief Constructor of the United States navy, Philip Hichborn, has called attention, in his annual report to the secretary of the navy, to the lack of docking facilities in the United States, making an urgent plea for more and better docks, pointing out that the navy has been at a serious inconvenience during the past six



U. S. S. INDIANA IN DRY-DOCK AT HALIFAX, N. S.

months for lack of proper facilities for docking battle-ships, and suggesting additional docks at Mare Island, Portsmouth, and Boston, and larger docks at Norfolk and League Island.

The disagreeable truth brought out so forcibly, in its purely military aspect, by the "Indiana" incident is just as repellent, if not as obvious, when considered in reference to the requirements of commerce. It is a rare event for an Atlantic liner to go into dry-dock on the western side of the ocean, for the reason that there are no suitable accommodations for them, excepting at Newport News and Philadelphia, where are dry-docks, belonging to ship-builders, which can be availed of for repairs, although not for the largest vessels, but whose remoteness from New York harbor makes their use too inconvenient to be resorted to ordinarily. Besides, the owner of a vessel usually prefers to have it docked at the home port when possible.

The lack of docks, as has been stated, is a serious disadvantage to the United States, viewed from a purely economical stand-point and considering naval ships alone; the difference in attainable speed, with the same coal-consumption, depending upon the cleanness or foulness of a vessel's bottom, is enormous, amounting in observed cases to 30 to 50 per cent. In extreme cases even greater differences in speed-capacity may be looked for. If the question of speed becomes paramount at such times, it can be only partly met by increased coal-consumption; thus various elements of waste are augumented,—*viz.*, excess of coal consumed, excess of outlay for wages and subsistence of the ship's people in performing a given duty, excess of interest and maintenance charges, and loss of effectiveness of the ship. The aggregate of this excess of cost, applied to the hundred or more naval vessels in active service, cannot be computed, but, if it could be, it would doubtless be appalling. When we consider that the United States have many ships that have cost for construction from $1,000,000 to $4,000,000 each, and that a dry-dock of the largest size costs not more than $750,000 and is available for many ships for years, the national policy of not making full provision at every port which the naval ships can enter seems radically defective and un-economical.

The nations of Europe show no such lack. Every maritime nation has a fine provision of graving docks and repair docks, generally in convenient juxtaposition to the commercial docks,—sometimes, indeed, a part of them. The graving docks for commerce may be quite distinct from those required for the naval establishment, though in certain ports a wise policy has been adopted of combining the two functions in one structure, and it seems very desirable that such a course should be followed by the United States government in its future provisions. For the non-technical reader a definition or two may here be needed. By a "graving dock" is meant any kind of a dock wherein a vessel may be artificially supported, and the water removed so as to permit of free access to her sides and bottom for the purposes of cleaning, painting, or repairs. According to the Century Dictionary, graving has two meanings, one being the act of laying in a grave, which the process of dry-docking suggests, and the other the operation itself of scraping and cleaning a ship's bottom.

A dry-dock is a basin established in solid ground, or at least partly surrounded by *terra firma*, into which a vessel may be floated, and from which the water may be entirely removed after closing the entrance-gate. The water may be removed by pumping, or, where the rise and fall of the tide equals or exceeds the depth of flotation, it can be emptied and filled by gravity.

In certain situations dry-docks can conveniently be placed so that their normal water surface corresponds with the half-tide, thus largely increasing the number of docking hours.

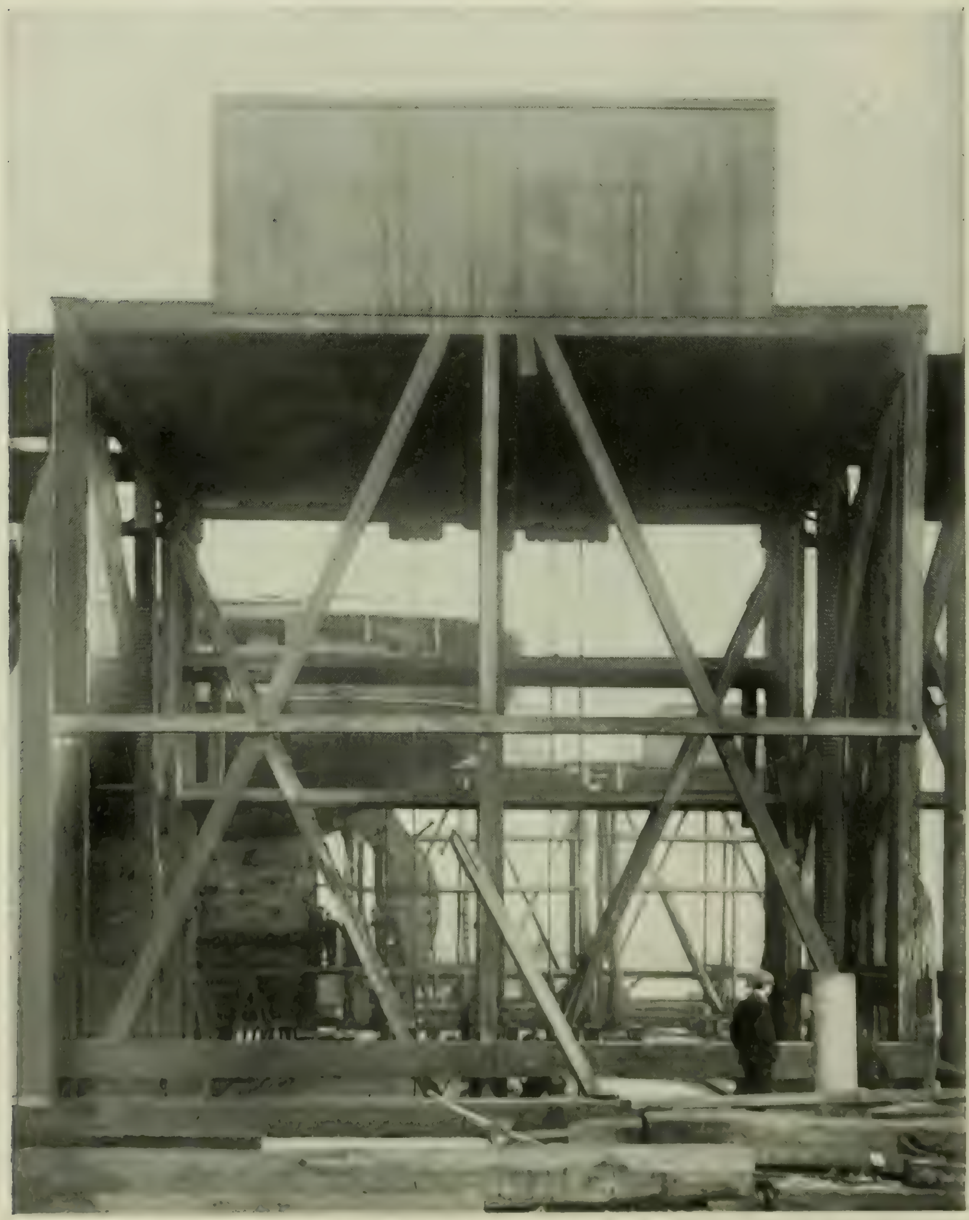
A floating dock is, in effect, a submerged platform, or pontoon, upon which is erected a cradle or other device to receive the ship's hull ; connected with the floor are chambers, which can be filled with water, to sink it, or with air, to raise it. The ship is floated above the cradle ; the water is pumped out of the chambers, causing the structure to rise to the ship and then lift the latter out of the water ; for convenience and better adjustment to the ship's weight and structural differences, floating docks are often made in sections, and are then known as "sectional docks." Of the latter type are the floating docks in present use on the East river front of New York, used for graving coastwise vessels, chiefly.

FLOATING DRY-DOCK ON EAST RIVER, NEW YORK.

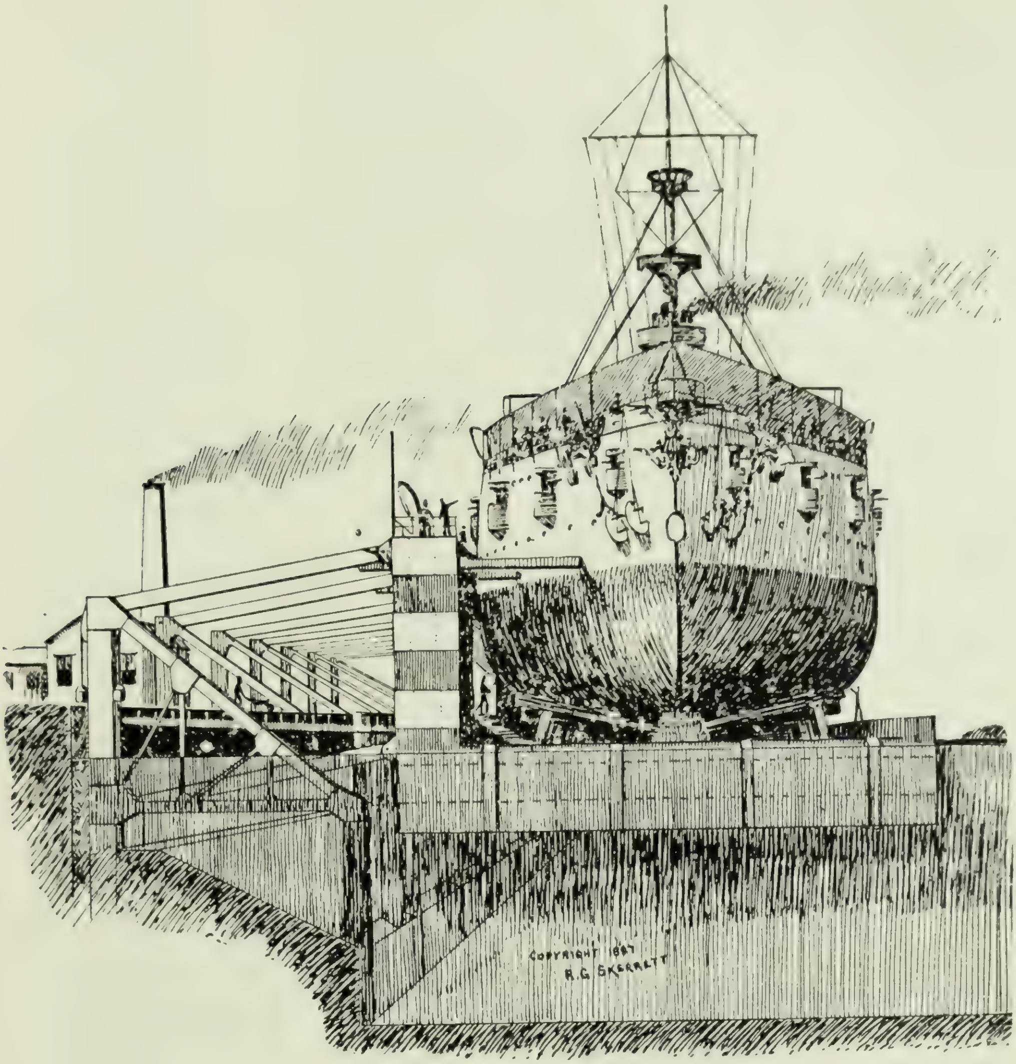
The illustration on this page shows one of these floating docks containing the steamer "Saratoga" of the Ward Line, running from New York to Havana. This dock is in ten sections : it is 380 feet long, 96 feet wide inside, 136 feet wide over all, and will float about

7,000 tons. A similar smaller structure, belonging to the same establishment, has nine sections; 280 feet long by 85 feet wide; capacity, about 3,000 tons; the view just below shows one of the sections.

The "off-shore" dock is a development of the sectional floating dock; in this type there is a submerged pontoon with a vertical extension above water on one side only, the purpose of the latter being to give stability to the structure and provide room for the pumps and other plant; the dock is placed parallel to the shore, with which it is



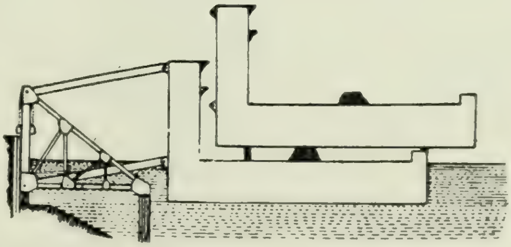
ONE SECTION OF FLOATING DRY-DOCK, SHOWING THE STERN OF THE "SARATOGA."



AN OFF-SHORE DOCK HANDLING AN ARMORED CRUISER.

connected by means of hinged booms moving in a vertical plane and permitting the dock to rise and fall.

An off-shore dock capable of docking a 17,000-ton ship, it is said, has recently been built for the port of Hamburg. There are manifest advantages in the off-shore dock as against the excavated or fixed form of dry-dock, and it will very



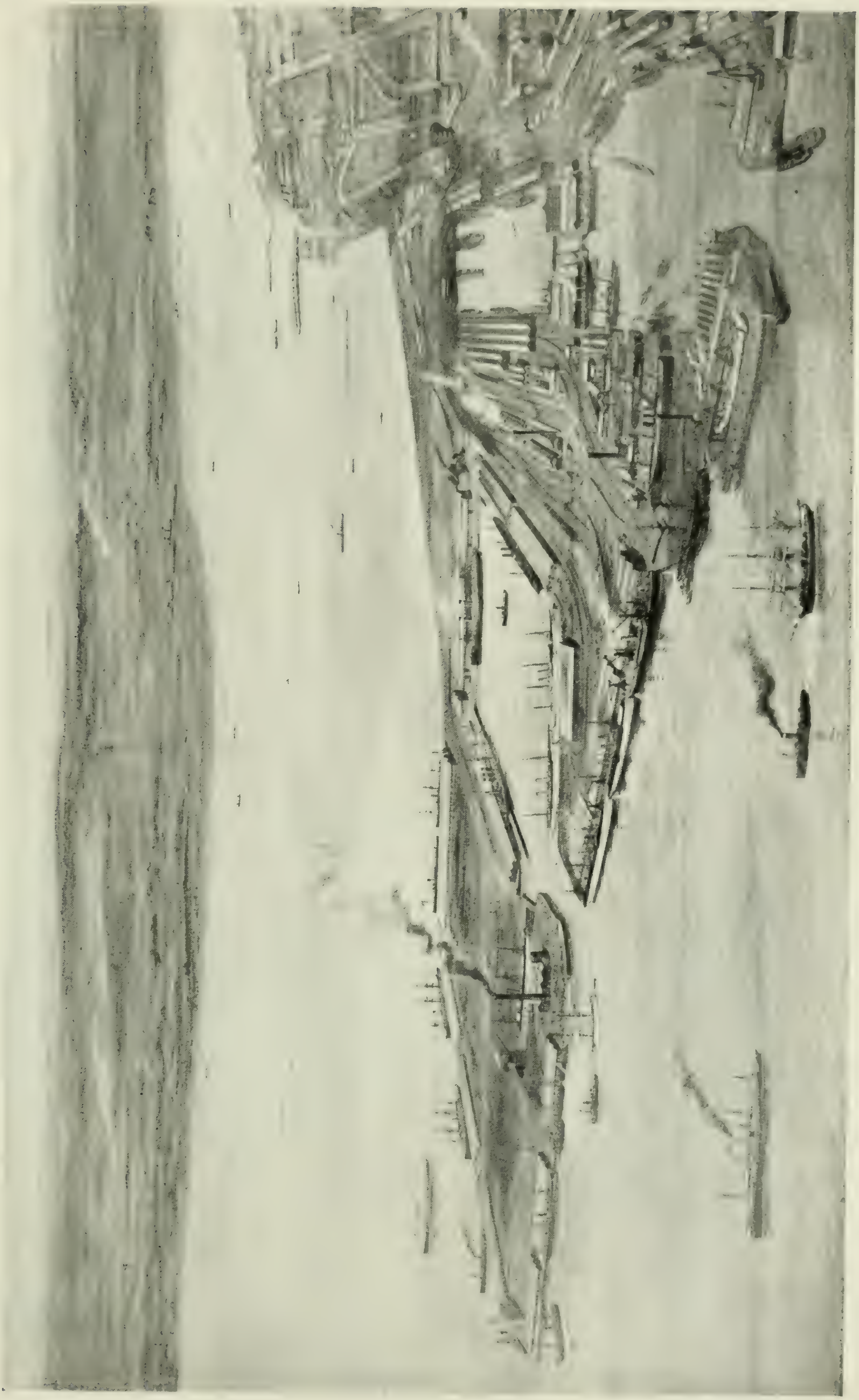
OFF-SHORE DOCK HANDLING ONE OF ITS OWN PONTOONS.

The cuts on this page are reproduced by courtesy of R. G. Skerrett and the New York *Times*.

probably be largely adopted in future; on the other hand, it requires a much greater depth of water. In the New York *Times* of October 31, 1897, appeared an interesting description, by Mr. R. G. Skerrett, of the off-shore dock and of several variations of the type. In one of these, called the depositing dock, the shore-work and booms are attached to a floating outrigger, and the whole dock can be towed from place to place; the pontoons are made in the shape of fingers, with water intervals between. A gird of heavy steel beams is fitted against the shore, the fingers of the dock slipping in between. A ship is taken upon the dock, towed to the gird, the fingers are run in, the dock lowered and removed, and the vessel is left deposited on the gird, convenient for repair, while the dock is free to go off to handle other craft. There is also a type, styled the "self-docking floating graving dock," which, apart from other differences, has movable end-caissons, by which it can be closed so as to become a floating graving dock, capable of navigation. The off-shore dock and its variations are essentially an English development, the credit of which is given to Messrs. Clark and Stanfield.

Another form of graving apparatus is the hydraulic lift, whose prototype is the celebrated structure at Bombay, the largest of the kind in the world, being capable of taking vessels weighing 5,000 tons, and having been tested to 12,000 tons. This is a very costly, but very perfect, machine; it consists of two parallel rows of eighteen iron columns secured to the rock bottom of the harbor, each column being 100 feet long and 7½ feet in diameter. Each column carries two presses with solid rams, 14 inches in diameter. The rams are secured to cross-heads, from which depend two rods supporting below water cross-girders upon which the 380-foot pontoon rests. The cross-girders are not connected longitudinally. The hydraulic presses are divided into three groups, controlled and operated by one man. The Bombay lift was designed for the P. & O. steamers before the opening of the Suez canal, since which event, however, those liners find it better to dock at Portsmouth.

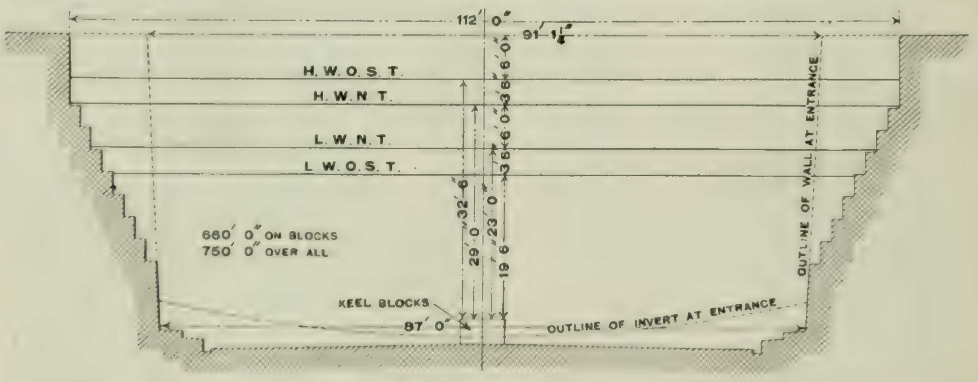
Beside graving docks, there are what are known as ship-railways, by means of which vessels can be floated into a cradle that runs upon an inclined railroad resting at one end on the harbor bottom and at the other extending up to dry land; the cradle is drawn out by a steam capstan, usually, and ropes and chains. Ordinarily the use of a ship-railway is confined to small vessels, and usually they are pulled out lengthwise; but in various parts of the world broadwise docking has been very successfully practised. The most notable apparatus for the latter operation is at Bordeaux, where vessels up to 310 feet in length and weighing 1,800 tons can be hauled out laterally.



GENERAL VIEW OF THE PORT OF SOUTHAMPTON, SHOWING THE EXTENSIVE DOCKS.
By courtesy of the General Manager of the London & South Western Railway.

Where it is desirable—as it is in most cases—to combine graving and repairs to hulls or machinery in one docking operation, the dry-dock lends itself the most readily to the work, although for small vessels the ship railway is a very convenient machine, and, for graving only, the floating dock, if of sufficient size, answers admirably.

For large steamers the graving dock should be fully equipped with permanent derricks, sheer-legs, and shops, for taking out, repairing, and replacing boilers and parts of engines ; in fact, it should be supplied for making all minor repairs without delay or loss of time. Such are the arrangements made in other ports than those of the United States, and in profusion. It is stated on intelligent authority that in Portsmouth, England, alone, there are now a greater number of dry-docks than exist in the United States. Liverpool's famous dock system, made indispensable by the great range of the tides in the Mersey, amounting to 30 feet or more, has about twenty graving docks in connection with her forty or more magnificent basins, which stretch, half a mile wide, for six miles along her side of the river, not counting those upon the opposite bank at Birkenhead ; generally the graving docks are conveniently placed in a corner of the basins, in close proximity to the repair-shops, and are marvels of enduring workmanship. The three graving docks in the Herculaneum docks are each 760 feet long by 60 feet wide, on the floor, excavated out of the solid sandstone rock and built of stone masonry.



SECTION OF PRINCE OF WALES GRAVING DOCK, SOUTHAMPTON.

By courtesy of the General Manager, London & South Western Railway.

To enumerate many such instances would be easy, but tedious and unnecessary ; it suffices to say, in general, that outside of the United States the provision for public graving docks is universal, and it seems about as needless to describe them as to describe the physical characteristics of European streets known by all to exist. But there are suggestive lessons to be learned in several fields from some of the examples of graving docks on both sides of the Atlantic. We may

THE ABERDEEN DRY-DOCK.

take at random the case of the port of Hull, to begin with, where in 1880 the mercantile community awakened to the economical and commercial importance of increasing its dock facilities, although it was already fairly well supplied, the celebrated Albert Dock having been in service since 1869, besides a number of smaller ones. A site of 192 acres was secured, within which a basin covering 46½ acres was constructed, with two miles of dock walls from 52 to 62 feet in

BUILDING THE NEW DOCK GATES, ABERDEEN, 1884.

The illustrations on this page are published by permission of G. W. Wilson, Aberdeen.

height, the range of the tide being 22½ feet; as necessary concomitants there were a lock entrance, 550 feet by 85 feet, 12 miles of railroad extensions, an artificial entrance channel, quays, sheds, hydraulic cranes, etc., besides two large graving docks. These works cost £1,355,392 ($6,750,000), or £29,147 ($105,735) per acre, including the two graving docks and their equipment; not including equipment, the cost was about £21,450 ($107,250) per acre, which is equivalent to about 10s. ($2.50) per square foot. The cost of the graving docks alone was £130,800 ($654,000). This work consumed five years in building. A large part of the site had to be excavated. The foundations of special parts of the structure had to be upon piles; the rest upon stone rip-rap. It can be used by vessels of the largest class, drawing 26¾ feet. Previous to the opening of the new docks, the tonnage of the port was steadily decreasing, but, after the opening, it steadily increased, many new trades being established.

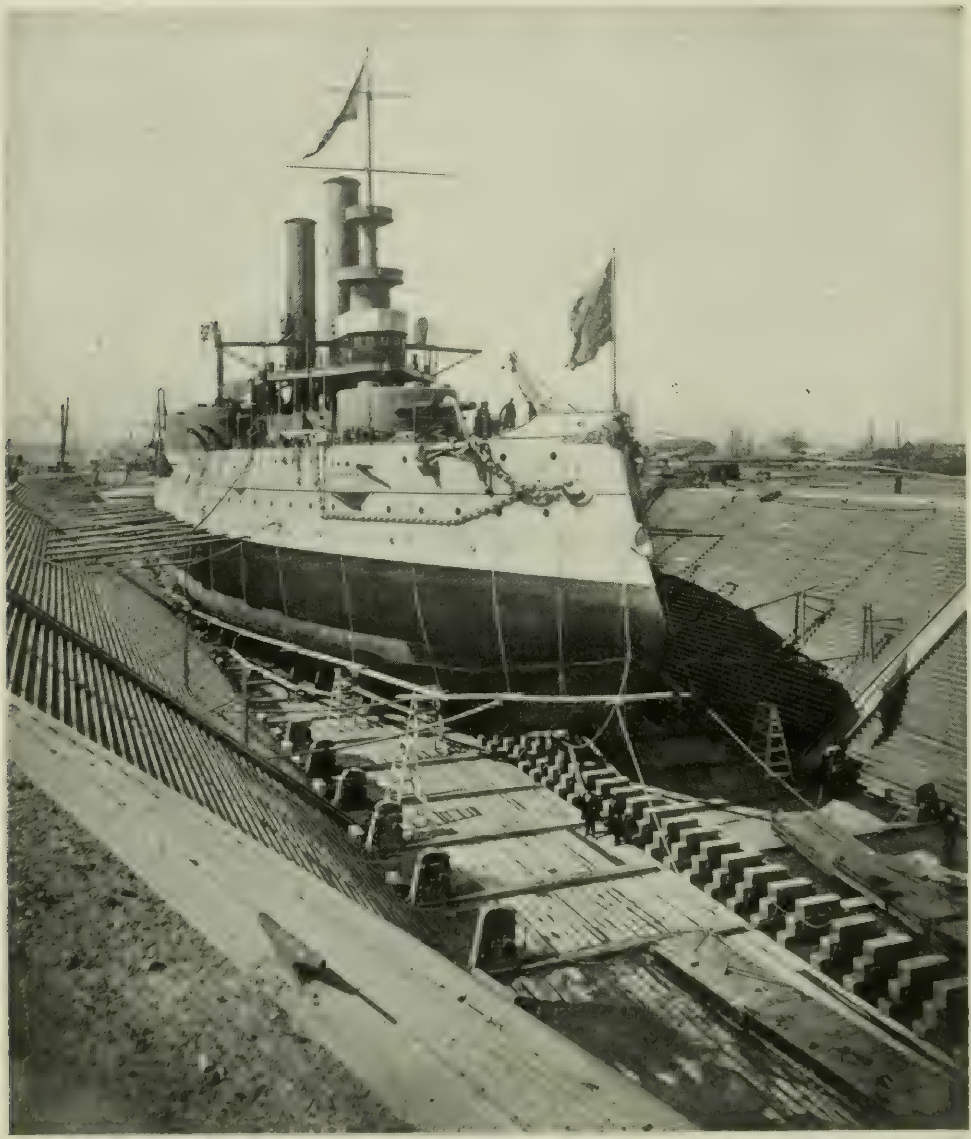
About the same date the port of Havre added to its already extensive system two large graving docks about the size of those just described; these were excavated in the solid ground, and are built of concrete. The two fine views of the Aberdeen Dry-Dock, showing it under construction, present very clearly the distinguishing features and magnificent workmanship of that famous structure, as well as a good deal of the detail. The Calliope Dock, at Auckland, New Zealand, 500 feet long and 40 feet wide on the floor, and giving 32 feet of water on the sills, is another notable graving dock; it was excava-

THE DRY-DOCK AT NEWPORT NEWS, VA., U. S. A., PARTLY EMPTIED.

ESQUIMAULT DRY-DOCK, NEAR VICTORIA, B. C.

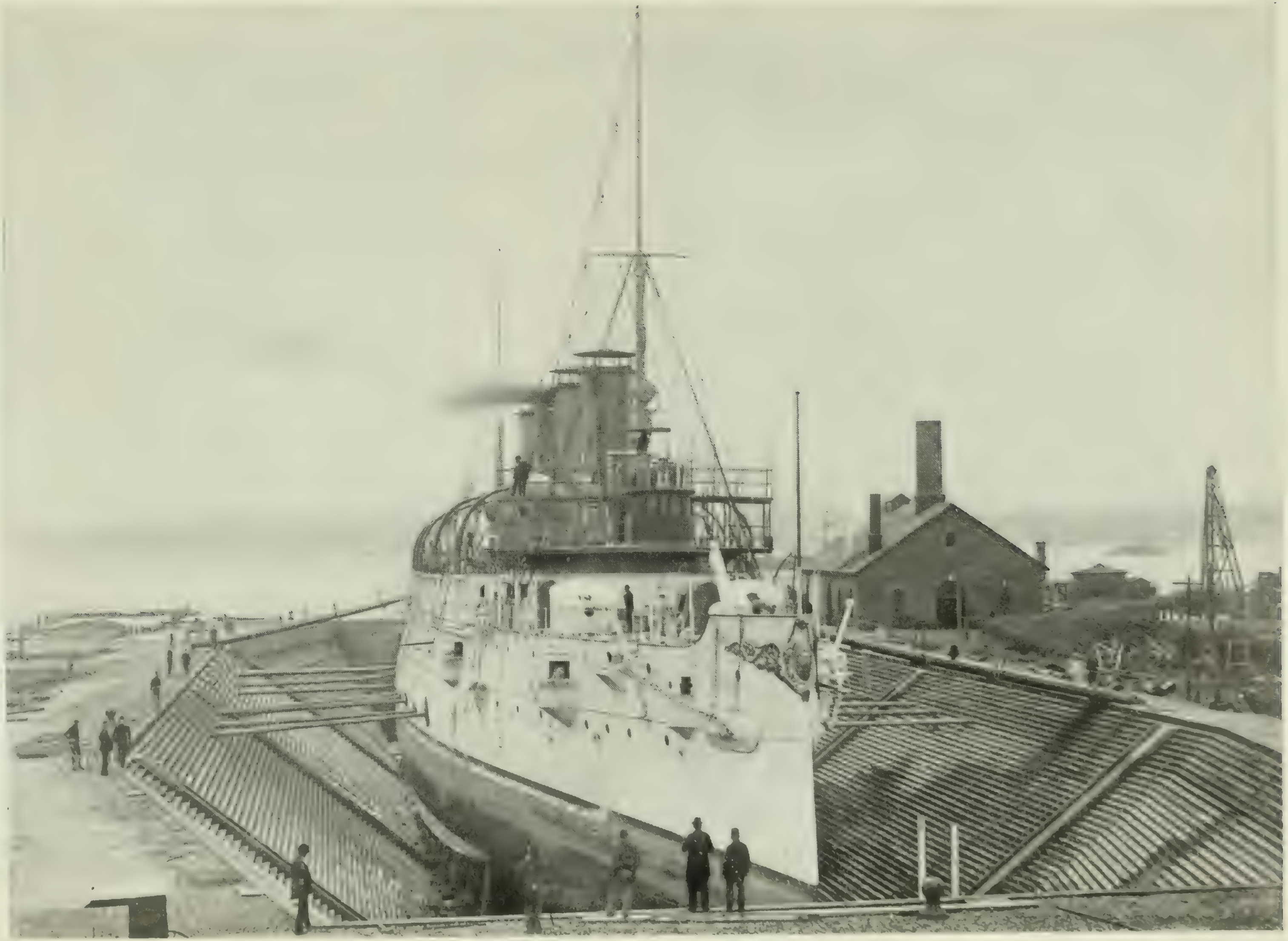
ted out of the solid rock, with altars and walls of rubble concrete. Its entrance is closed by a wrought-iron caisson, 83 feet by 15 feet by 41 feet. At Hull, gates are used.

Wherever the Union Jack floats, the British government, or a colonial government,—which, for the object in view, is practically the same thing,—has its splendid graving docks. The "morning drum-beat that goes round the world" has its counterpart in the cordon of docks provided for British commerce and British battle-ships. One

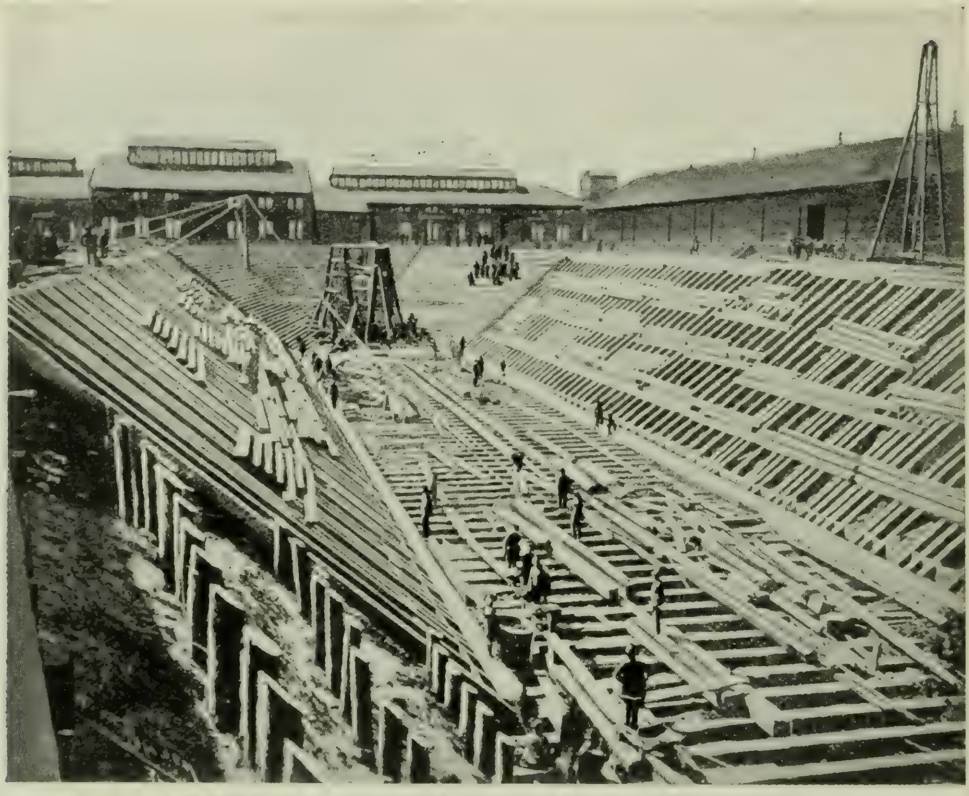


U. S. BATTLE SHIP IOWA IN THE LARGE DRY-DOCK AT THE U. S. NAVY YARD, BROOKLYN, N. Y.

of the finest modern examples is the Esquimault Dock, near Victoria, B. C., herein illustrated. This is a typical masonry graving dock. It was commenced by the government of British Columbia and completed by the Dominion of Canada, the imperial government contributing £50,000, in return for which Her Majesty's ships have priority of entrance and free dockage for fifteen years. At this point the range of tides is very variable and uncertain, being about ten feet normally, but remaining practically level for days together. The capacity of this dock is 450 feet by 65 feet with a depth of 26½ feet, sometimes increased by the tide to 30 feet. Its site was solid ground; the walls are of rubble concrete faced with sand-stone; the altars and timber-



DRY-DOCK AT THE UNITED STATES NAVY YARD, LEAGUE ISLAND, PENNSYLVANIA.



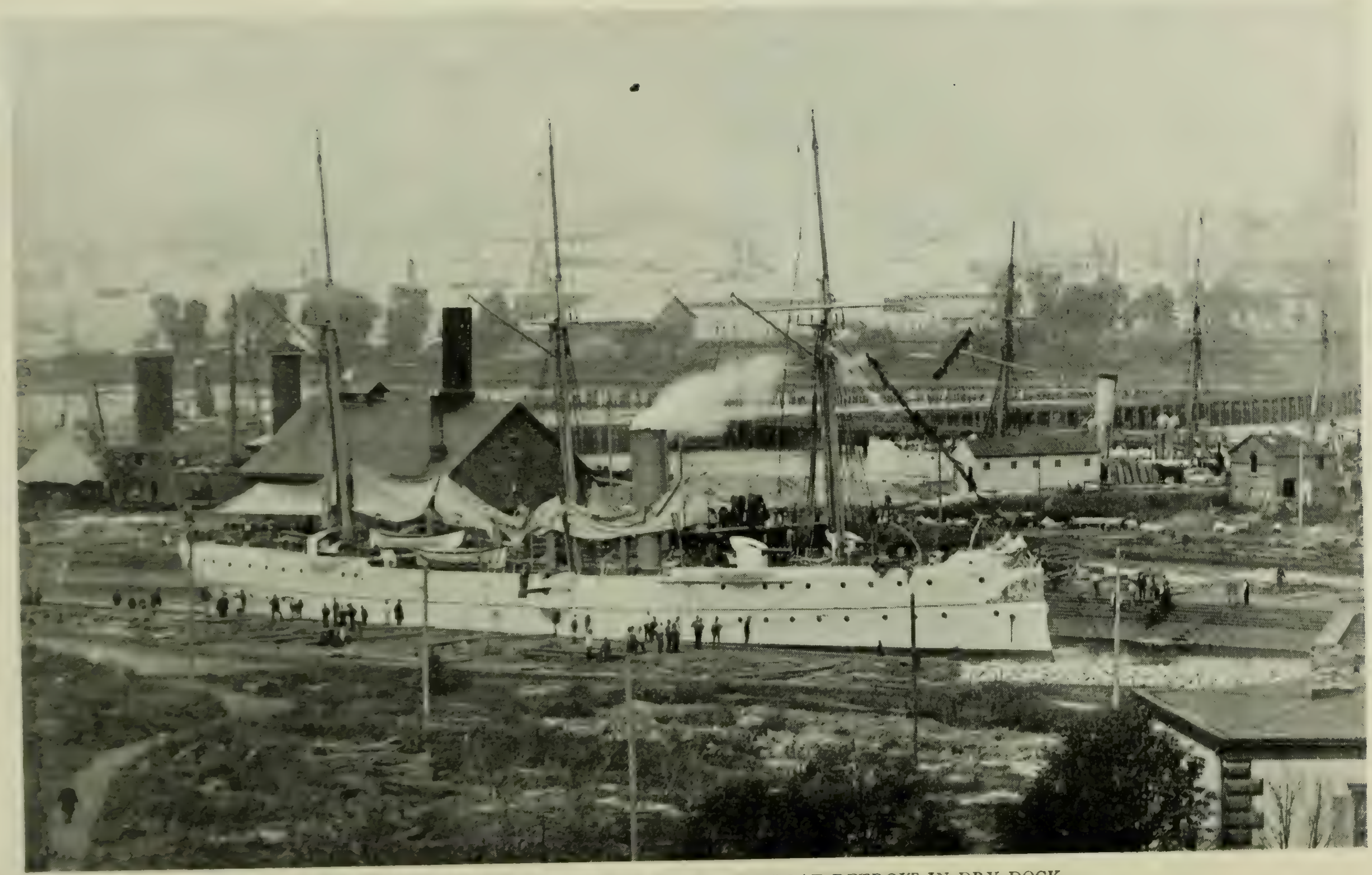
A " SIMPSON " DRY-DOCK IN COURSE OF CONSTRUCTION.

slides are of masonry. It is closed by means of an iron caisson having a displacement of 530 tons and weighing 294 tons, besides 180 tons of concrete ballast. The caisson is constructed with a lower chamber for water ballast, and an upper flotation chamber; it has two keels, which rest upon fixed rollers, over which it is drawn by steam-power chains. As there has long been a dispute between the advocates of stone and timber dry-docks as to their advantages, it may be of interest to note that the Esquimault Dock cost about $1,500 per lineal-foot, fully equipped; and it is stated that an extension in length would cost about $1,000 per foot for the dock-structure alone. Wooden docks of similar capacity have cost about $1,000 per foot, but two at the Brooklyn navy yard are said to have cost $640,000 each, which would be somewhat more than $1,000 per foot; this, however, does not include the very extensive repairs that subsequently were necessary. It should be borne in mind that there are other points of comparison besides cost. On the Atlantic coast nearly all the later graving docks are of wood, including the United States government docks at Port Royal, Norfolk, Brooklyn, and League Island; there is also an older dock, of masonry, at Norfolk. Of private graving docks there are the Newport News Ship-building Company's establishment, the Cramps' dock on the Delaware, and one at Baltimore,—all of wood.

All of these wooden docks are of the kind known as the Simpson dock, from its inventor; its typical construction, as first adopted, is shown in the illustration on the opposite page and comprised a wooden floor, as well as wooden walls and altars; but it was found that the wooden floor was often lifted by the upward water pressure from underneath, and one dock, at least,—that at Portland, Oregon,—it is said failed from this cause. The modern type has a concrete floor with wooden sides, and generally is closed with a floating iron caisson. The League Island dry-dock is 500 feet long, 130 feet wide at the top, and 32 feet deep; it cost $550,000. About 7,500 piles were required to support the bottom and sides; it will take a vessel 400 feet long by 70 feet beam on 25 feet draft. The caisson is 88 feet long at the top, 54 feet on the bottom, 20 feet wide, and 32½ feet deep; its keel presses against a heavy sill, on the face of which is a semi-cylindrical strip of rubber, serving as a gasket to make a water-tight joint under the water pressure. This device is the one commonly used for the joint. The caisson is emptied and filled by special pumps.

The colonial government's graving dock at St. Johns, Nova Scotia, is said to be one of the finest of its class on the Atlantic seaboard; this also is a "Simpson" dock. At the time of its completion it would take any merchant vessel afloat, except the Great Eastern. It

THE DRY-DOCK AT HALIFAX, NOVA SCOTIA.



U. S. NAVY YARD AT BROOKLYN, N. Y. GUNBOAT DETROIT IN DRY-DOCK.

is 610 feet and 10 inches long, from head to outer gate-sill, has 558 linear feet of keel-blocking, and is 25 feet deep. It is situated at River Head, the western end of the harbor of St. Johns, in an excavated site. It has a concrete bottom, and is closed by means of a gate moved by a steam capstan.

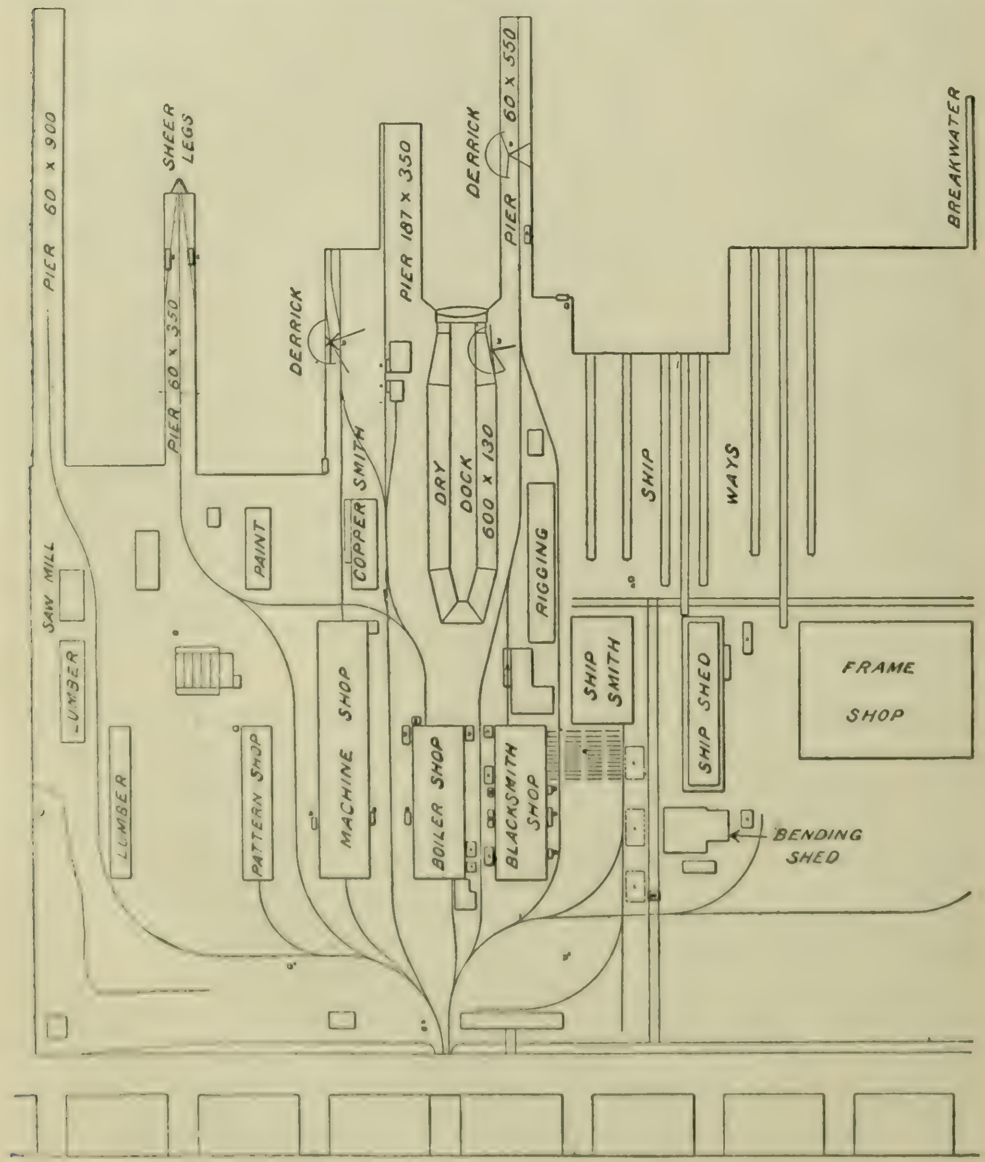
The dry-dock at Halifax, in which the Indiana was docked, is 620 feet long, 89 feet wide in the entrance, 102 feet across the top, and 28 feet deep at mean high water. It was excavated in solid rock. It is of brick and concrete, and belongs to the Halifax Graving Dock Company, Limited, a private corporation. The Indiana is 348 feet long over all, and 69 ft. 3 in. beam, drew 24 feet of water, and weighed nearly 10,000 tons when in the dock.

The Newport News dry-dock is 600 feet long, by 84 feet and 9 inches wide, by 25 feet deep. It stands on piles throughout; in most other respects it is similar to, and practically identical with, the St. John dock. The general plan, furnished through the courtesy of Mr. C. B. Orcutt, on page 462, shows the location of the dock at the entrance to the ship-building yards of the Newport News Ship-Building Company.

At present there are no graving docks on the Atlantic coast of the United States south of Port Royal; Naval Constructor Hichborn, in the report above mentioned, calls attention to the suitability of the harbor of Algiers, on the Gulf coast, for the establishment of a dry-dock; and very recently the directors of the Port Arthur Dock and Channel Company decided to build a dry-dock at Port Arthur, Texas, capable of taking a vessel 500 feet in length and of accommodating at one time any two United States cruisers now afloat. It is of interest to note in passing that the capital for this enterprise is to come from Holland.

On the Pacific coast of North America there are only a very few graving docks; besides the Esquimault Dock, a fine wooden dock in Puget Sound, and the one which failed at Portland, there is the very expensive Mare Island dock, built of granite and concrete, which was begun in 1878, and is said to have cost $2,500,000 (£500,000). At the Union Iron Works in San Francisco there is an hydraulic dry-dock somewhat similar in construction to the Bombay Lift, above described. It consists of a submerged platform built of cross and longitudinal girders of steel, with keel blocks and sliding bilge-blocks, which is raised by means of thirty-six hydraulic rams with a traverse of 16 feet multiplied so that the platform plays 32 feet vertically. The support consists of seventy-two iron cylinders driven full of piles. This plant lifts 6,000 tons, and handles, on an average, more than ten vessels per month.

Other facilities for encouraging and fostering commerce—not only that which exists, but that immensely greater commerce yet to be created for the United States—in the shape of more complete systems of lighting and marking channels, better harbor entrances, more convenient arrangements for examination by revenue and health officers, etc., are doubtless needed in some, if not in all, United States ports. But in these respects the country has not been greatly neglected in the past, and, with the added impetus that would come from improvements along the lines marked out in this series of articles, it may fairly be said that the harbor conditions on the Atlantic coast of the



GENERAL PLAN OF WORKS, NEWPORT NEWS SHIP-BUILDING AND DRY-DOCK CO., NEWPORT NEWS, VIRGINIA, U.S.A.

United States would need little improvement not already accomplished or in contemplation. Development in these respects would naturally go hand in hand with new necessities.

On the Pacific coast of the United States, however, very much remains to be done in providing the harbors themselves. Only a few months ago the board appointed by the United States congress to locate a deep-water harbor for commerce and of refuge on the Pacific coast completed its investigations, and selected San Pedro, California. In the admirable report presented by that board occurs the following suggestive sentence, of much interest in connection with our present subject: "The recent changes in the requirements of deep harbors, and the methods used in their construction and maintenance, are in favor of a harbor where commercial facilities are afforded by interior basins rather than by exterior wharves, in which basins perishable types of bulkheads or piers may be displaced by permanent structures of such reasonable cost as the growth of commerce may justify."

But, whatever the local conditions may be in United States ports, their modern commerce is in its beginning, and there is a common interest, not only on the seaboard but especially in the interior, in stimulating it, in building it up, in creating it, to be a stay and support for generations yet to come. The country has seen and been blinded by its wonderful material progress in the last thirty years, accomplished without needing, for the time being at least, commerce with other nations under home control. But the times have changed; the home field is in many respects nearly occupied; the commercial era is at hand for the United States, just as twenty years ago the industrial era presented itself.

The late ex-Commander Gorringe, U. S. N., himself a shipbuilder, once said to the writer that for every man engaged in the production of a ship there were fourteen employed in the commerce which that ship served; from this he argued that it was much more important for the United States to own and operate many ships than for few people to make an excessive profit in building the small number made possible under the American protective policy and the outgrowing navigation laws. However men may disagree as to the prime cause of the disappearance of American shipping, there can be no question at this time of the desirability to the United States of taking every reasonable means of fostering and encouraging it.

COST-KEEPING METHODS IN MACHINE SHOP AND FOUNDRY.

By Henry Roland.

III.—CONTROL OF THE STORE-ROOM AND CHECKING OF PIECE-PRODUCTION.

USING general terms, there are in the foundry and machine-shop or factory rough stores, work in progress, work delayed, finished stores, and assembled or completed work.

Rough stores include everything bought from the outside, and may include finished articles, as screws and bolts, bright shafting, finished pulleys, finished special parts, and so on. Except pig iron, coal and molding sand, and tool-room supplies, rough stores are, or invariably should be, checked into the rough-stores room, and thus placed in care of the rough-stores keeper as soon as received at the works. The foundry stores, flour, nails, facing, and so on, might well go to a store-keeper in large establishments, but commonly do not, being accessible at will to those who have occasion to use them, with the result of much waste which might be avoided if these miscellaneous supplies were in charge of some responsible person and served out in known quantities only to those who should receive them. Rough stores for the brass foundry—copper, tin, spelter, and so on—are usually in charge of the foreman in small shops, or of a stores keeper in large shops, because they are costly and in portable form, and thus offer temptations to petty thieving, or constant thefts not at all petty in totals. Rough machine stores are almost invariably placed in charge of responsible keepers, as they include a vast variety of articles which may be wasted or stolen, if open to all hands; these stores should be checked into the stores-room, thereby making the store-keeper their responsible custodian, and checked out of the stores-room only on authenticated orders, such stores-room books being kept as to always show what has been received, what has been given out, and to whom and on what account stores have been delivered.

Space does not permit the giving of approved details of rough-stores arrangement and book-keeping, which are of necessity greatly varied by the nature of the manufactures to which they pertain. The rough stores of a screw-making establishment may consist wholly of metal bars and rods, or, in case of a general machine-shop, rough stores may include a very great variety of materials in greatly-differing forms. Stores-room book-keeping may be nothing, the stores-room keeper merely filing the orders on which he delivers material, or it may be a complete system, including journal and ledger, the journal only being kept in the stores-room. Two journals are often used, one for each alternate day, so that the one in use on the previous day can always be in the book-keeper's office. Such stores-room book-keeping should be done as will give accurate knowledge of all transactions, and the rough-stores room should have internal conveniences that will permit all its multifarious contents to be readily reached, handled, weighed, or enumerated.

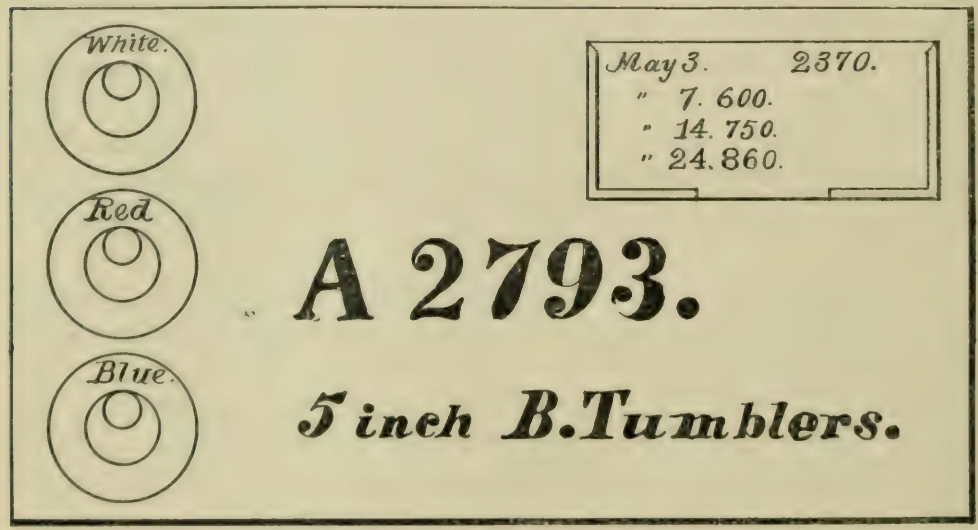
Shop jobs are supplied with material from the stores-room on job orders, as already exhibited. When a job is completed, it goes, in heavy work, commonly to the erecting department, but, in light work, it goes to the finished stores-room to await the demand of the various assembling departments. If, through some emergency or a change of plan, a job is delayed in its finishing, it then becomes a thing without a place, belonging in neither the rough stores, the finishing department, or the finished stores. A delayed job is always expensive, and should be sedulously avoided. Perhaps the best disposition of the delayed jobs of small work is to box and tag it, and place it in the rough-stores room. If left in the finishing shop, shoved out of the way and often out of sight, it may be forgotten altogether, and is at least liable to be short when work is resumed upon it.

Finished stores demand suitable internal facilities, and careful book-keeping, showing totals of finished stores on hand at the shortest possible notice.

Where, as in the case of the Yale & Towne establishment, the finished stores include many hundreds of different pieces of small size, racks of boxes of uniform dimensions may be used, two boxes deep, with alleys between the racks, each box bearing the name and number of the piece and having a flush card-slide on its front side, the card recording the original number of pieces contained and each withdrawal, each box having also three target pins, and three targets, white, red, and blue. With all three targets on the upper pin, white exposed, the box contains an ample supply of parts; white on the first and red on the second target pin show that the supply is running low; while the blue target exposed on the lower pin shows that the stock must be replenished immediately. Thus, by merely observing the targets, the finished-stores keeper can tell what parts are full, what ones are short, and what ones must be ordered into manufacture as soon as possible, without moving a box or examining a card or book. These targets give constant visual warning of low supply, and the Yale & Towne finished-stores box, as shown in the engraving below with all the targets displayed, gives a valuable item of established finished-stores room practice.

Assembled small wares or machines go to the shipping department, where again everything should be checked in and checked out, and such a set of books kept as will give full information.

The De La Val shops are arranged with the rough stores at the extreme south end, under the offices; next north comes the finishing-shop, with tools arranged so that, as far as possible, those nearest the rough stores are first used. The assembling floor, testing floor, and painting, Japaning, re-assembling, and boxing and shipping rooms, are in sequence north of the finished stores, thus giving the least possible transportation inside the shop, which is a matter of great importance. Many shops unconsciously add a considerable percentage to prime cost by handling of jobs in process of finishing and finished. Every handling costs money, and in more ways than one.



YALE & TOWNE FINISHED-STORES BOX.

In the matter of thefts, losses, spoiled work, shortages, and disappearances, the most surprising and incredible happenings are of daily occurrence in the machine-shop as well as in the world at large, and, just as we occasionally read of the wholly unaccountable disappearance of some individual respected and well known in his circle, so work of all kinds, jobs large and small, disappear from the machine-shop or factory as if swallowed up by the earth, and in many cases leave no trace behind which ever leads to recovery.

A large, finished, double-cranked refrigerator engine-shaft, 11 or 12 inches in diameter, perhaps 20 feet long, and weighing several tons, disappeared from the De La Vergne shops, Port Morris, New York, and left no trace whatever behind. Long afterward this shaft was found, quite accidentally, by one of the De La Vergne officials, who saw it lying unclaimed on the ground in Cincinnati, thought it looked like a De La Vergne shaft, found the marks on it, and recognized it as the lost piece. No trace was ever obtained to tell certainly how it came there. It was probably a case of unauthorized shipment, ambiguous billing, and so on, which permitted the separate flat-car load formed by this lost crank shaft to accompany an authorized shipment of machinery to the west as far as Cincinnati, where it became a stray, was side-tracked, and, having no distinguishing marks, was finally laid on the ground for developments.

This was out of the common, but losses of great value are not exceptional in the machine-shop and foundry.

In a Chicago foundry the iron for the day's heat was broken, weighed, and piled in the yard before noon, and the weights came short in the total of finished castings, wasters, and sprues with unvarying regularity,—about 100 pounds on every day's work. The foundry adjoined a machine-shop, and the broken pig was piled where a strapping Hibernian smith's helper could easily secrete pieces, and he carried out about 50 pounds morning and night, and disposed of it at a convenient junk-shop. The smith's helper was detected going out of the gate with half a hundred weight of pig iron slung over his shoulders and concealed by the very loose rough jacket he wore. He went to jail, and the foundry weights came right. Here the careful Germans who ran the foundry kept their weights closely enough to detect small losses.

In the large Sag Harbor silver watch-case factory all the silver in the establishment was checked into the silver-keeper's strong-room, both as rough stores and work in progress and finished stores ; everything was weighed out in the morning to the melters and to the finishers, and weighed in at night, and the silver-weights book was balanced before the gates were opened to let the hands out. The proprietor walked through the shop two or three times one day, and, being above suspicion, he easily stole 120 ounces of his own silver, and then waited for the disturbance which he expected to follow a 120-ounce shortage in the silver balance at night. Nothing came. As the silver-keeper was leaving the place, the proprietor gave him a smile and a nod : "Balance all right, eh?" "To a quarter of an ounce," replied the silver-keeper. Nothing more was said that night, but the next morning trouble began in earnest. The book-keeping system was all right ; the silver-keeper and his weighing and checking clerks were lazy and careless, and the balancing of weights was habitually forced. No one was discharged, but the weight balance was a matter of anxiety from that time on.

In a book-bindery a million copies of a medical almanac were in progress. A girl folder who had folded twelve thousand sheets erroneously took the stitcher and coverer into her confidence, and the three girls, all on piece-work, passed the books through to completion, had their piece-work books checked up with credits for the work, passed the greater part of the spoiled twelve thousand copies down the soil pipe, and took the remainder out of the bindery at night in their clothes and lunch-baskets. The shortage was never explained, the writer learning of the incident from one of the culprits, who told it as a good joke on the bindery.

In a sewing-machine shop one hand never spoiled work. A deep mill race ran under his window. When the dam went out in a freshet and the race went dry, it exposed many thousands of pieces of that man's spoiled work, which he had thrown into the water, making good his shortage in job-ticket numbers by eating noon lunch with the finished-stores keeper in the finished-stores room, and filling his lunch-basket with finished parts from the finished-stores. The finished-stores accounts were not subject to trial balance before the dam went out. Afterward the finished-stores books were balanced often, and the stores-keeper lunched alone.

The Rock Island Railroad shops in Chicago had about seven or eight hundred hands in the early sixties. Two new helpers sent down from the office were put at work; they looked smart enough, but were of absolutely no use anywhere, and were passed from one department to another, being everywhere made the butts of the workmen, who were accustomed to "main office" hands—as men sent down from headquarters simply to draw pay were called. The whole place, from the paint-shop to the boiler-shop, had fun with those two helpers for a couple of weeks, and then came a Saturday afternoon when all the workmen were asked by their foreman to give up their tool-box keys as they left the departments for the day. Some of the men did not wish to let their keys go out of their hands, but all were taken up. At the exit-gates stood the two "main office" hands and two policemen, and it was very slow work passing out of the gate because, at a nod from the "helpers," a man was taken into the oil-room, where there was vacant floor-space, and searched before he was allowed to go out. No one was held, and only about half were searched. More than eight hundred dollars' worth of "company" material was taken from the workmen at that single search, including samples of nearly everything used in making freight and passenger cars and locomotives. Two of the blacksmiths, father and son, Englishmen, two of the best men in the forge-shops, were found to have carried out, by some undiscovered method, an anvil, a large old-fashioned smith's forge bellows, two vises, a large lot of tongs, files, axes, fullers, formers, sets, hammers, and sledges, and, in addition, more than ten tons of bar iron and steel. They intended soon to start a shop on their own account. The two smiths were sent to prison, and a few of the thievish workmen were discharged, but, taking it all together, there was very little said. The tool-box keys were returned Monday morning without a word; some of the hands' tool-boxes had been relieved of company property, but nothing was said to most of the men, the company, probably, justly blaming their own lax methods—which gave the opportunity for wholesale plunder—more than the men who "took" what was not properly guarded.

Every man familiar with American shops can recall numbers of similar tales, all made possible by lax shop-methods. Most mechanics are honest, perfectly honest. Many workmen will cover up a bad job, and many others will take a file or two, or a little material they want to use, carrying it out of the shop without saying anything to anybody.

A small class of mechanics, often very bright and capable workmen, are simply vicious thieves, and display incredible skill and ingenuity in devising methods by which a slight gain to themselves may be secured at no matter what expense to their employers.

Many swords and bayonets were lost in tempering in a Massachusetts armory many years ago. Finally the boss forger tried his hand at tempering with a secret heating compound and bath of his own, and all losses ceased immediately; the secret of the tempering bath was sold to the firm for a large sum, and the successful temperer left for parts unknown. After his departure a large unused tempering-vat was found to be filled almost full of temper-cracked sabres and bayonets. Slack rough-stores accounts and collusion with the sword and bayonet forgers and grinders had enabled the dishonest temperer to obtain untempered pieces to make good his work spoiled in perfecting the non-cracking tempering bath, the secret of which he sold to the firm.

In another case, reported by a correspondent, an establishment using what was supposed to be a reliable system of shop accounts found at the end of the year six thousand of a certain piece recorded as paid for at piece-rates, which could not be found or accounted for in assembled work.

These numerous anecdotes are given as showing more plainly and conclusively than any argument could do the absolute necessity of a complete bookkeeping and checking system in the shop and factory, with a sufficient clerical force to carry out all details with promptness. Short accounts make long friends. It is not enough to have a reliable method of handling work and keeping track of it in the shop. There must be frequent balances and actual counts. The counts can generally be made very quickly by weighing, to show that the actual condition of work corresponds with the footings of the accounts.

Piece-work and job tickets make prime-cost keeping easy; day-work tickets, carefully kept, serve the same purpose with a little more labor. Day-work tickets are very often incorrectly filled by workmen and foremen, who are inclined to turn in short time on bad-luck jobs, charging the difference to the work which went through in quick time. But original records cannot well go back of the workman and his immediate superior; so this uncertainty of time division must be regarded as an ever-present possibility where a day workman is employed on more than one job in the same day. Many different systems of shop-accounts can be used in dealing with shop-operations. The simplest is best, but simplicity must not be gained at the expense of the possibility of accuracy. In general terms, the tendency of present practice is towards a multitude of accounts, and elaborate sets of books, the same as the tendency in the shop is towards special lines of work and special tools and appliances, whereby processes are subdivided and steps are simplified, so that both shop-processes and shop-bookkeeping progress toward that mere mechanical routine which demands only small ability and no exercise of ingenuity or skill, and thus ensures accuracy from mediocre agents.

Constant vigilance must be exercised in the shop, not only to secure good work, but to avoid dishonesty on the part of the workmen. It has been said that most workmen are honest. It cannot be said that all are honest, nor can it be said that all honest workmen can always do honest work. The superintendent must avoid placing tempting opportunities for petty frauds before his men. Workmen must not be left to their own devices.

Tool-room supplies include a great number of costly articles which should never be allowed to go out without a record of the taker. The check system is very commonly employed, each workman being supplied with from five to ten small brass checks stamped with his individual number. The workman gives one of these checks to the tool room keeper with the request for a desired tool, and the tool-room keeper places the check in the vacancy left by the delivered tool in its rack. The check makes the workman stand charged with the missing tool until it is returned to the tool-room, and the workman has his check returned to him in exchange therefor. Oil is often kept in the tool-room, and is also often exposed in the shop in an "oil cabinet," to be taken by the men as they see fit. Cotton waste is often kept in a bin or barrel, accessible to the men, and in this form is a fire danger, besides leading to wasteful usage. Files should always be kept in the tool-room, and delivered only on a foreman's order. Many shops make it a rule to deliver a file only in exchange for a worn similar file ; but this is not a good rule, except in cases where the workman is employed continually on the same class of work. Stubb's wire and gun rods are often kept in the tool-room rather than in the rough-stores room, and should always be delivered on job order only. Spring wire and brass and German silver-wire, and sheet brass and sheet steel and tool steel, are also, in some shops, stored in the tool-room, and should be delivered only on job orders, though many tool-room keepers are permitted to deliver wire and sheet metal stock without orders. Where this is done, all such material should be charged to expense when it enters the tool-room. For accurate cost-keeping no stock can be delivered to a workman except upon job ticket or job order. Still, it is perfectly true that where a workman wants, say, one-eighth or one-sixteenth of an ounce of small spring wire, the time expenditure in keeping the record may be many times more than the value of the material delivered. The workman may spend some minutes in finding his foreman and obtaining a tool-room order on the job ticket for the wire he wants, and, if the tool-room keeper's accounts must balance, he must make a record ; so that, in case of extremely small deliveries of stock to workmen, the shop is loser by keeping the record. This makes an excuse for not keeping the tool-room stores account with accuracy, and leads some shops to charge all such stores in a lump to the expense account. The same general objection can, however, be urged against all attempts at accurate cost-keeping, and, since accurate cost-keeping is now held to be an essential part of good shop-management, the formalities needful to securing prime-cost records must not be ignored. In this connection it is proper to note the fact that wire and sheet-metal supplies should have a large percentage added to the original cost on the job tickets, say, from 50 to 100 per cent., as the larger figure does not in many instances represent the actual cost of time in placing the small amount of material needed in the workman's hands at the shop location where it is to be used. The fact that all stores incur shop charges and should bear a proportion of the expense account or "establishment charges" is elsewhere noted. Expense is created by everything brought into the shop, or produced by the shop, and must be recognized in every instance, if accurate cost-keeping is sought.

Many shops fail to understand this feature of total cost, but a charge of from five to fifteen per cent. on first cost of materials is always justifiable as expense on materials not to be machined, or before machining or working in the shop.

Before leaving the finished-stores room subject, it is well to note that it forms a central element in the shop economy, and some shop accountants have therefore made the finished-stores room the central figure of a system of book-keeping, charging all work to the finished-stores account, and crediting everything given out by the finished-stores keeper. Such a system had an extended trial at the Yale & Towne factory, but was abandoned as involving too much book-keeping for the benefits gained. By this method the whole shop accounts center in the finished stores. The scheme has its strong advocates, despite the clerical work involved.

It is not enough that the keepers of the rough-stores, finished-stores, and tool-room should be simply not thieves; these officials must be of conscientious and untiring integrity, omitting nothing, however small and inconsiderable, that pertain to their duties. Nothing short of this will produce accurate records, and inaccurate records are liars of the most damaging description in machine-construction.

Estimating is based on prime cost and expense, or "establishment charges," as British shop accountants term them. It is therefore an absolute necessity that prime cost should be accurately known, since the expense account is divided into percentages on prime costs, or percentages on values of materials and other percentages on the total cost of labor used in the construction of work delivered. Consequently accuracy in all the details of account-keeping which have been mentioned is necessary, not only to prevent pilfering and the obtaining of pay for work not performed and the loss of material and finished work, but to enable the management to furnish estimates to inquirers at prices which include a living profit.

Although the vast labor of thus supervising and recording an infinity of small details, unimportant when singly considered, might lead the old school of founders and machinists to assert that the best way to manage a metal-working establishment at the present day is to let some one else carry on the business, it must be borne in mind that the demand for machinery is daily becoming both greater and more varied, and will continue to employ constantly-increasing amounts of labor and capital for many years to come, and that foundry and machine-shop management is one of the most important branches of commercial science.

THE FAILURE OF LEGISLATION TO ENFORCE RAILWAY COMPETITION.

By H. T. Newcomb.

THE purely American belief that there can be general, permanent, and effective competition among various corporate units collectively composing the railway system of a nation, and that such competition itself constitutes a substantial regulative force, has had abundant legislative expression. In the attempt to secure and perpetuate railway competition, provisions forbidding the consolidation of parallel or connecting lines have been inserted in American State constitutions, in acts of American State legislatures, and in the charters of carrying corporations. In pursuance of the same policy various States have, to the extent of their authority, prohibited arrangements, popularly called "pools," for the equitable division of competitive traffic or the earnings therefrom, and, through the persistence of a few doctrinaires, the United States congress, in 1886, inserted the fifth section, or anti-pooling clause, in the interstate commerce law, with every other provision of which it is in irreconcilable conflict. Finally the anti-trust law, by what many eminent jurists believe to be an unwarranted application of its terms, has been so construed as to prevent all agreements among railways in regard to the charges to be collected for services performed.

It is interesting to note that this apparent confidence in the saving efficacy of competition in transportation is practically confined to the United States. In England, where "joint purse" arrangements for the apportionment of earnings from competitive traffic are almost as old as the railway system, it is notable that an award made by Mr. Gladstone, acting as arbitrator in a controversy over the division of business among the four companies operating northward from London, was in force continuously from 1857 to 1871. France has been divided territorially among several great companies, each of which is practically free from competition in the field reserved to it; while in Germany and most other continental countries, as well as in Australasia, the business of railway transportation is a State monopoly.

The end of a decade during which legislative attempts to foster railway competition have been a principal element in the situation in the United States affords a fitting opportunity for inquiry concerning the success or failure of this peculiarly American policy. Though judicial interpretation has considerably modified what was at least popularly supposed to be the legal effect and purpose of the interstate commerce law, the application of the anti-pooling section has been in no way restricted, and its enforcement has been practically continuous. It is not too much to assume, therefore, that the United States have now received whatever benefits can be derived from unrestricted competition ; yet railway rates remain demoralized, and complaints of unjust discriminations in favor of particular persons, communities, and classes of property are loud and frequent. It is true that the penalties attached to rate-cutting, the payment of rebates, underbilling, and other fraudulent devices through which charges lower than those accorded to the general public are collected from favored shippers, have so far restricted those practices that those who ship in small quantities are no longer able to "shop" among the various roads over which their traffic can be forwarded, finally patronizing that which agrees to accept the lowest compensation. The statement made in an official report by Mr. C. C. McCain, the highest American authority on the history of railway charges in the United States, that "in former years the methods of the carriers were such that the instances where the published tariff was charged were rather the exception than the rule" is not applicable to the period subsequent to 1887; yet there is abundant evidence that concessions are regularly made to those shippers, or combinations of shippers, whose enormous wealth, or the extent of whose business operations, enables them to dictate terms to carriers, wherever alternate routes exist. It is impossible to doubt that the social consequences of unjust discriminations are vastly more disastrous when granted sparingly and reluctantly to a few, and that the unfair advantage accorded the individuals thus selected is much more valuable than when variations from the established rates are made at the behest of every sufficiently sophisticated shipper. Indeed, it is manifestly greatly to the advantage of the fortunate individual who is able to command a concession from the published rates amounting to all or nearly all the difference between a profit and a loss in the business transaction of which the shipment is a by no means unimportant part, that every other individual making similar and contemporaneous shipments shall be obliged to pay the regular charge. The interstate commerce law, which could by no means secure competition and at the same time abolish the ordinary means by which it is made effective, has secured for the larger shipper the inestimable privilege of reasonable confidence that the illegal favor which he enjoys can be secured by no small competitor.

There are other effects of so-called railway competition which are equally disastrous to public interests though not necessarily involving violations of the interstate commerce law. Unjust discriminations may result from the establishment of different and inharmonious schedules of rates by independent railways, as well as from the action of a single road in performing similar and contemporaneous services upon variant terms for different individuals. For example, if A and B simultaneously ship equal quantities of the same commodity between the same points and in the same direction, and A is charged less than B, the commercial disadvantage resulting to the latter is neither more or less on account of the route traversed by either shipment. Similarly, it cannot be of the slightest importance to the residents of a district competing with those of some other district for the privilege of supplying a particular community with some necessary product whether the relatively unjust rate that deprives it of equality of opportunity in the market common to both is over a line owned by the corporation over whose road the traffic from the unfairly-favored locality must pass. Evidently, therefore, it is essential to an equitable distribution of the burdens of transportation not only that single railways shall charge similar rates for similar services, but that all railways capable of performing similar services shall establish and maintain identical charges therefor. Anything less than this involves unjust discriminations and demoralization. Uniformity in charges made by separate corporations involves agreement among them upon mutually-satisfactory schedules, and effective agreements upon the complex subject of railway charges require continuous machinery for joint and harmonious action. Beyond this, it has become plainly evident, within the last decade, that satisfactorily-permanent uniformity cannot be maintained unless there be established some system comprehending a substantial incentive for adherence to agreements after they have been formulated, and successfully substituting for the superficial spirit of rivalry and conflict now too frequently prevalent among railway managers thorough appreciation of the absolute identity of the corporate interests which they serve. As long as the ownership of the railway system continues to be distributed among a large number of legally-separate corporations with different security-holders, and their surplus revenues to be divided, in consequence, among distinct bodies of investors, the requisite harmonization of interests can be achieved, if at all, only by the division of all traffic for which two or more routes are, from a commercial standpoint, practically available among the carriers operating such routes, in proportions stipulated in contracts the observance of which may be enforced by judicial process.

Though railway competition enforced by statute has failed to secure the public against unjust discriminations, it might still receive some popular support, if it were possible to show that it has resulted in cheapening transportation. Here a somewhat plausible affirmative argument can be made by the mere assumption, which will frequently pass unnoticed, that coincidence of time and place establish the relation of cause and effect. Average charges for railway transportation are, per unit of distance, lower in the United States, especially for freight, than elsewhere in the world. The whole period of the development of railway facilities has been characterized by a downward movement in rates of fare and freight which is one of its most salient features. Careful investigation of the incidents of this decline show clearly, however, that it is due to causes wholly extraneous to the railway system, except in so far as the enlightened perception, on the part of the officials having charge of railways, that the future of those properties is based upon the development of the territory contiguous and tributary to their lines, and that such development is largely dependent upon cheap transportation, can be considered an intrinsic cause. The genuine competition of trade, and not the pseudo-competition of transportation, is the cause with which the decline in railway charges can be logically connected. Persistent and powerful pressure is constantly exerted to secure concessions in rates, in order to place particular producing regions upon a better footing in markets already reached, or to extend the areas which they can supply. Such concessions, however slight, may be sufficient to enable one region to monopolize a market formerly common to several, and thus lead to demands upon other carriers reaching the common market from different directions. The sugar of Hawaii and that of Cuba and Germany thus find common markets in the United States, and whether the sale of one or both in large districts shall be profitable or the reverse is wholly a question of transportation rates. Salt from Michigan and Kansas meet in Iowa and other States on similar conditions, as do many other commodities in various portions of the country. Competing shippers in the same locality are always endeavoring to obtain more favorable rates than those accorded to their rivals; and, though these may be, under present conditions, temporarily secret, they not infrequently lead to open reductions. The use of particular commodities is often limited territorially by the freight charges from the points of production to those of consumption, and, when charges are too high on certain articles, substitutes produced nearer the points of consumption, or carried at lower freight rates, are frequently used. The charges for passenger transportation also, by limiting the distance to which agents can be profitably sent and otherwise hindering personal communication, effectively prescribe the limits of profitable interchange of commodities, and interfere with the territorial division of labor. In consequence of these facts, the whole force of commercial competition, the most amazing and tremendous product of modern industrial and economic organization, is arrayed in continuous effort to secure ever-cheapening transportation. As a result, railway charges tend unceasingly toward the lowest rates that will produce a revenue sufficient in the aggregate to meet operating expenses, including necessary repairs and renewals, and, in addition, return to capital the lowest recompense for which it can be procured. As the latter is at any particular time a definite and ascertainable sum, it is evident that expenses of operation constitute the only controlable element. Here is found a barrier which legislative attempts to secure railway competition have erected against further reductions in charges made possible by economies in operation. There is thus imposed upon the public the burden of supporting, by rates otherwise unnecessarily high, this peculiar form of competition that is profitable to no one, and is the prolific parent of unjust discriminations.

Some of the wasteful expenses incident to competition may be enumerated here. Authentic statistics of the amounts paid by rival lines as commissions for securing business are very difficult to obtain, as the success of such practices depends very largely upon the degree of secrecy that it is possible to attain. The interstate commerce commission was able to ascertain, however, that nine roads paid out an aggregate sum of more than one million dollars in a single year in commissions on passenger business alone. It is stated on reliable authority that as much as $20.70 has been paid to secure a single second-class passenger from Chicago to San Francisco. The multitude of outside agencies and travelling agents maintained solely for the purpose of securing the business for their respective lines that might otherwise go by those of their competitors involves an expenditure so great, even during periods of comparative harmony, that it has been necessary to restrict their number by contract. The contract now in force limits to eight the number of these agencies that may be maintained in the city of New York by each of the nine roads competing for through west-bound traffic. As it is a fact of ordinary observation that such agencies invariably cluster in particular portions of the city and around particular corners, it is obvious that, under a system of joint agencies, the public could be accorded superior service at lower cost. During the too-frequent periods of unbridled competition, popularly denominated "rate wars," each participating road has its freight and passenger agents in every important city in the country, at a total expense for rents, clerk-hire, advertising, etc., that must be enormous. Four roads operating westward from Chicago are known to have expended $1,283,585 for outside agencies and advertising in a single year, during which rates were fairly maintained, while during an equal period one road out of New York expended $871,291 for similar purposes. The competition of long, circuitous, and otherwise costly routes for traffic that would naturally traverse cheaper and more direct lines is another gross extravagance too frequently observed. Between Omaha and St. Paul, with a short-line distancc of 373 miles, traffic is carried by a line 734 miles in length. From Chicago to New York twenty-one routes ranging from 912 to 1,376 miles compete for traffic, while between Omaha and San Francisco there are five, of which the shortest is 1,865 miles long and the longest 2,724. Besides the numerous regular and "tramp" steamships available for shipments from New York to New Orleans, more than ninety all-rail lines are each actively seeking a share in the business. The most direct of these is 1,340 miles in length, or 711 miles shorter than the longest. As an example of the waste of competitive train service, it is not necessary to add anything to the bare statement that forty-four trains leave Chicago for New York every day, and that similar duplication of service exists all over the country. No intelligent student of transportation doubts that, whenever it becomes possible, by means of the adoption of wiser principles as the basis of regulative legislation, to eliminate from the cost of railway operation these economically useless and wasteful expenditures, the saving thus effected will accrue to the benefit of the general public through the reductions in rates which will be thus permitted to result from the action and interaction of the commercial forces heretofore described.

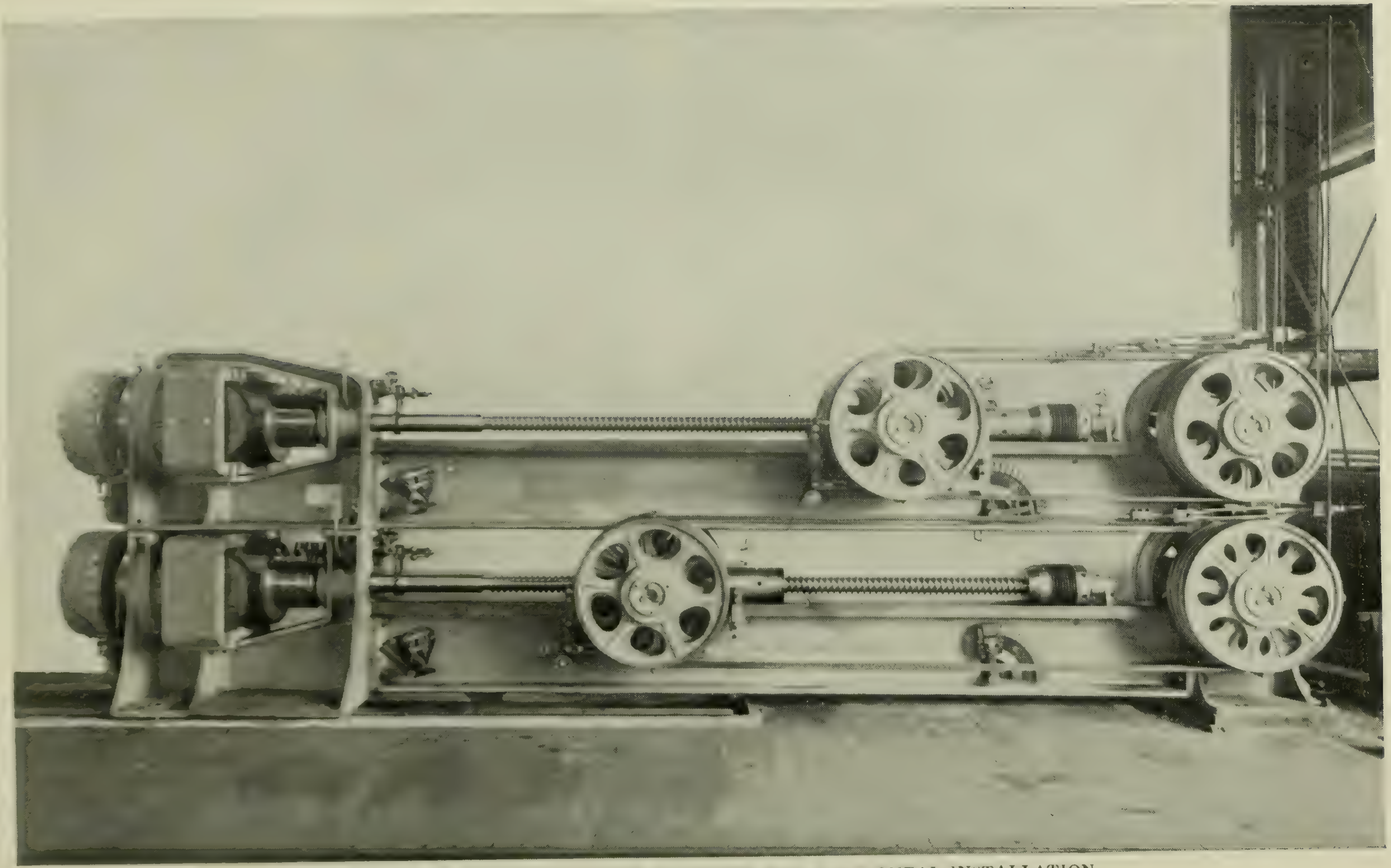
Though this rapid summary of the failure of so-called competition among American railways would be complete without it, it may be useful to indicate that it is not due to any cause invalidating the competitive principle as applied to general business and within its proper sphere, but rather to the fact that the modern conditions of land transportation are such that genuine competition among the agencies employed is impracticable. Far the greater number of railway stations are dependent upon single railway lines, and the vastly larger portion of railway traffic has no alternative routes available. To these stations and this traffic the relation of the railway corporation is that of a monopoly, and from them the latter can and will, within certain limits and with certain qualifications which are not at all essential to this discussion, recoup all losses that may be sustained at the comparatively few points, and in carrying the relatively unimportant traffic, with regard to which there is actual competition. The inevitable result is that whatever reductions may be made at the points where true competition exists operate as unjust discriminations against the points having but one available line, while the unnecessary expenses entailed in keeping up this competition must be borne by enhanced average rates.

STANDARDS OF PRACTICE IN ELECTRIC-ELEVATOR INSTALLATION.

By Percival Robert Moses.

THE questions arising in the design and construction of elevators have received little attention in the technical press,—a surprising omission in view of the number of fatal accidents occurring, the majority of which could be avoided by consideration of elementary mechanical principles. The importance of the subject in the United States is indicated by the fact that there are more than 6,000 elevators in New York city alone, and a low estimate of the car-trips made per day is more than 500,000; while the passengers certainly outnumber those carried by the street and elevated railroads combined. The growth of this branch of the industry can be compared only to that of the "trolley." From barely 3,000 h. p. on the central-station service in 1894 the number has increased until there are now more than 10,000 h. p. installed. The elevators operated from isolated building plants probably bring the total to nearly 20,000 h. p.

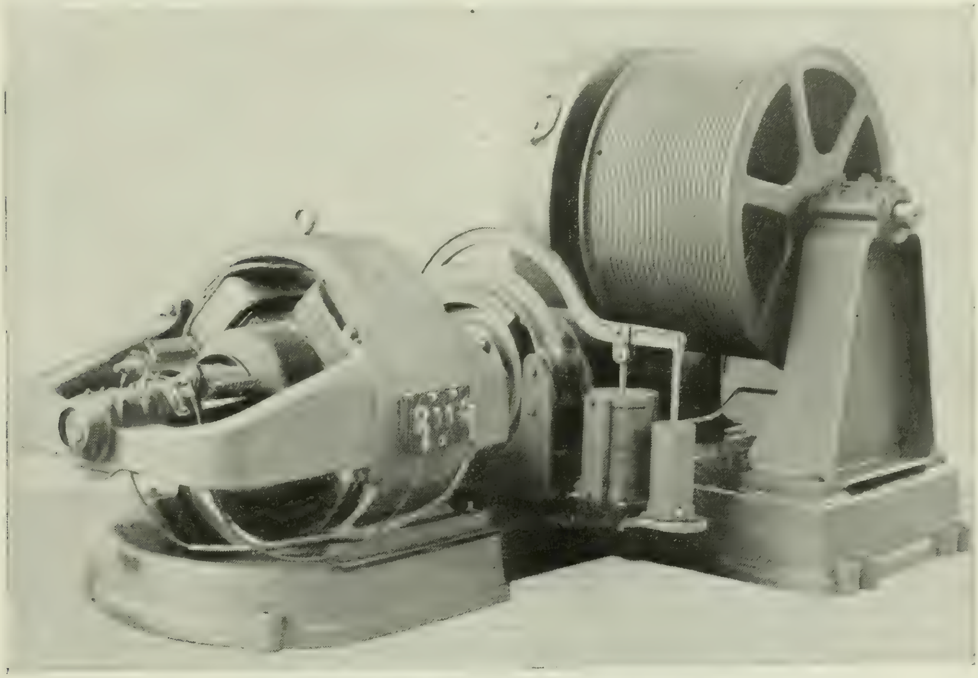
In Great Britain and on the continent the development has barely commenced, but its possibilities are hardly calculable. Experience has shown that facilities for vertical traffic are the direct result of increased means of rapid transit on the level. While business men were restricted to the slow-moving horse-car or cab, business interests were scattered; the ship-owner had his office at the dock, the lawyer was at the courts, and the manufacturer at his factory; as a consequence, the building of five stories fulfilled all requirements, and the lift was a luxury. The advent of comfortable rapid transit and the telephone changes these conditions; the separate trades draw close to each other by means of business offices in the city, and the ensuing contraction causes the high building to spring up and the lift to become a necessary tool in the "manufacture of transportation." The new electric underground railroads in London will lead to the building of tall buildings of twelve stories and upward, notwithstanding the present laws, as the elevated railroads have already done in New York and Chicago. That the elevators used in these and smaller buildings will be operated by electric motors there can be but little doubt, and a study of the actual conditions will not be out of place. The mechanical problems encountered and overcome are more severe than those of street railroads; the elevator car



HIGH-SPEED DOUBLE-DECK SCREW MACHINES FOR HORIZONTAL INSTALLATION.

Manufactured by Sprague Electric Company.

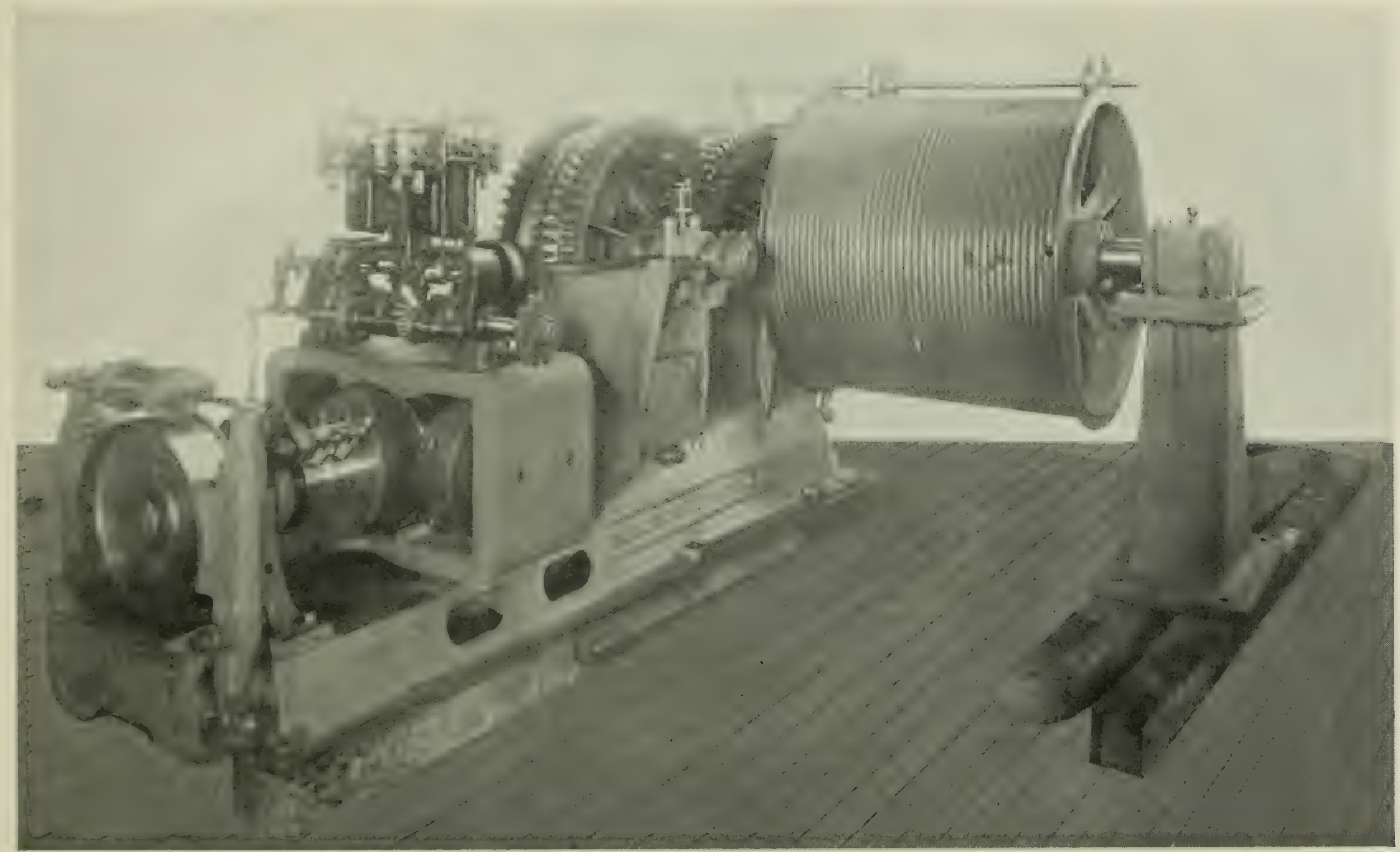
runs on a hundred per cent. grade, is able to attain a speed of 600 feet a minute without jerking, in about a second and a quarter, and may be stopped in the same manner and time. It must be capable of continuous operation, as there is no car-barn into which it can be run and repaired while another is substituted to do its work. Space is limited, and a shut-down of one elevator out of six in a large office-building is a serious annoyance during the busy hours. Moreover, it must be absolutely safe and easily operated. On the other hand, the advantage of a clean, clear track and continual supervision of the operating mechanism is obtained.



SINGLE WORM-GEAR DRUM ELEVATOR, WITH ELECTRO-MECHANICAL SAFETY BRAKE AND SOLENOID CONTROLLER.

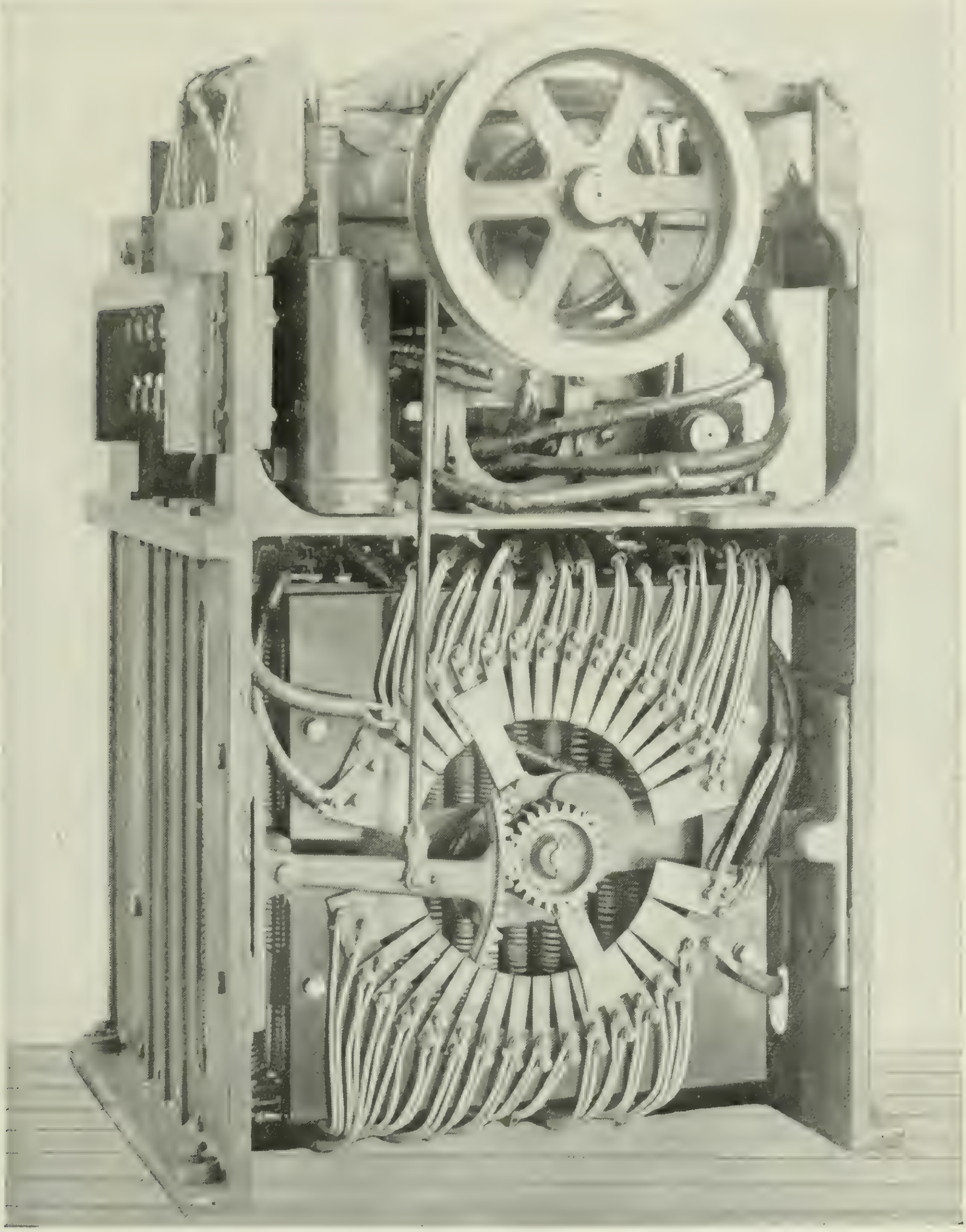
Manufactured by Elektron Elevator Company.

Elevators are divided into those for passengers and those for freight. In the former, three sub-divisions, depending on the speed, may be recognized, *viz.*, high speed, from 300 to 700 feet a minute; medium speed, from 150 to 300 feet; and low speed, or less than 150 feet per minute. With freight elevators only two speeds—medium and low—are necessary; high-speed freight is invariably carried by one of the passenger elevators during slack hours. In general, that passenger-elevator system is the best which gives the greatest speed consistent with safety and comfort at the least cost of operation and maintenance. The most efficient freight system is the one which transfers greatest loads quickest at the least cost of operation and maintenance.



TANDEM WORM-GEAR DRUM ELEVATOR WITH ELECTRIC CONTROL, INTERLOCKING AUXILIARY SPUR-GEARS, AND DOUBLE WORM GEARS.

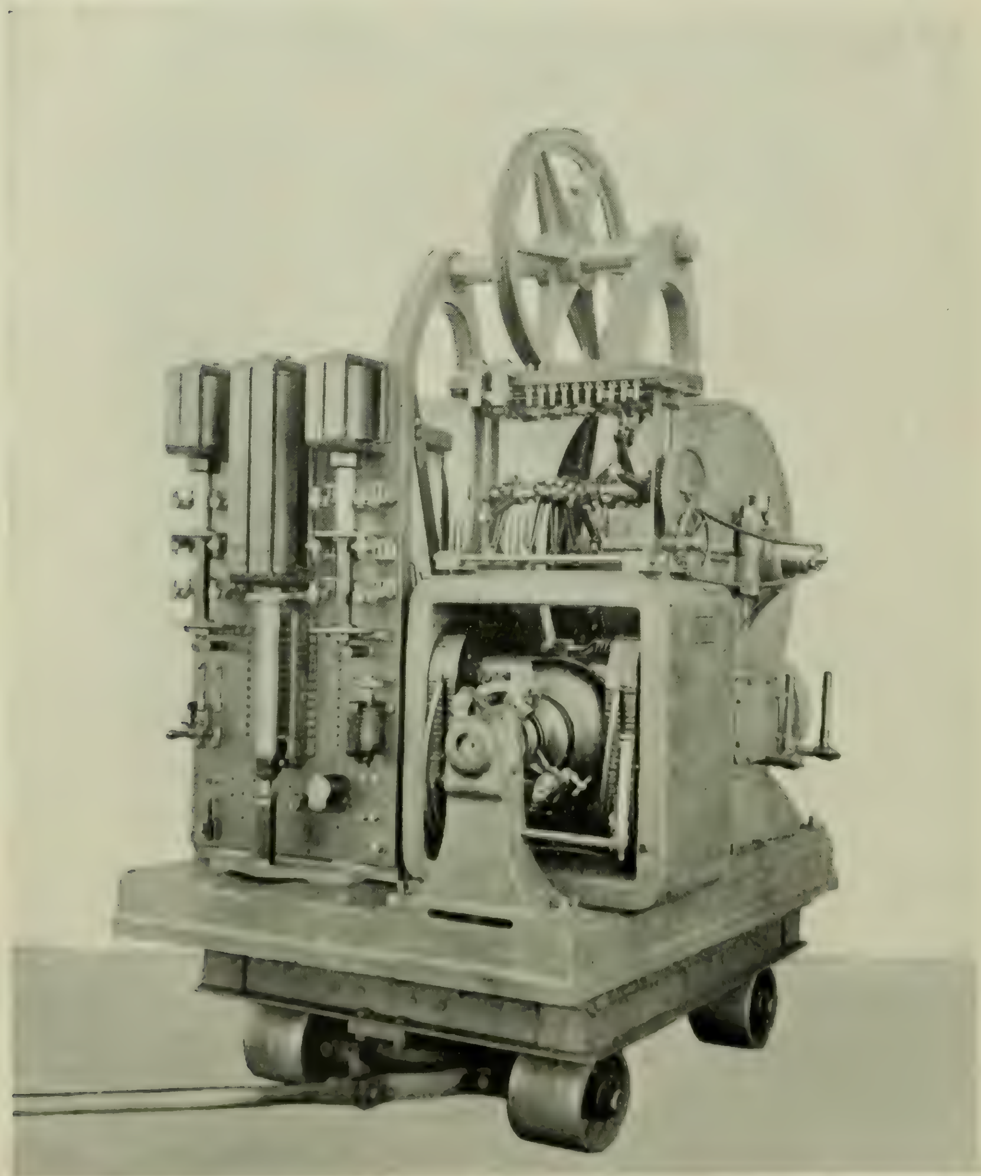
Manufactured by the Sprague Electric Co.



SOLENOID CONTROLLER OF ELEKTRON WORM-GEAR DRUM.

To meet the varying requirements of speed and load three types of electric elevator have been perfected, and numerous others advocated. The three are the screw with multiple sheaves, the double worm-gear drum, and the single worm-gear drum. The methods of operation of the last two are similar, the difference lying in the absence of all end thrust and increase of bearing surface with the double machine due to two worms and wheels and interlocking gears; otherwise each has an electric motor keyed to a shaft directly coupled to the worm shaft, which operates a large worm wheel directly attached to a drum on which the car and counterweight ropes wind, transmitting movement to the car. Motion is arrested by removal of power and by application of brake on the motor shaft or closing of the motor circuit through a resistance, causing work to be done by the car or by both.

The screw type was built to compete with the high-speed hydraulic, and closely resembles it in many characteristics. Like the ordinary hydraulic elevator, it is constructed for either horizontal or vertical installation; transforms power at low speed into power at high speed by nests of sheaves and a sheave on the counterweight;



AUTOMATIC HOUSE-ELEVATOR, WITH PUSH-BUTTON AND SOLENOID CONTROL.
Manufactured by Sprague Electric Company.

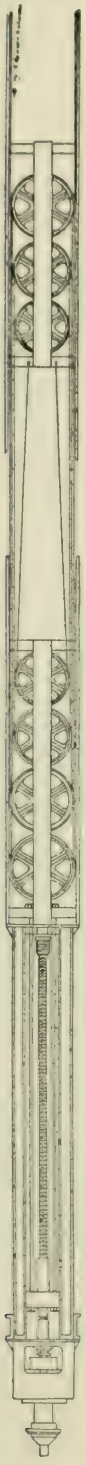
has absolute and fixed limits of travel; raises the car by power, and lowers it by gravity; has a fixed lead of the ropes in the hoist-way; and allows of equalization of their work at the machine. These factors are of great importance for all high-speed work. The method of operation is as follows: power is delivered to an electric motor coupled to a forged-steel screw; rotary motion of the screw transmits lateral motion to a travelling cross-head, by a so-called frictionless ball-bearing nut, to which is attached a nest of sheaves. Ropes from the car (or counterweight) travel over these sheaves and a stationary set (at the end of the machine away from the motor), multiplying the velocity of the nut eight to ten times. Motion is arrested as in the drum machine, but the action is assisted by gravity instead of being impeded.

The car is caused to lower by the attraction of gravity, the speed being regulated by a variable resistance in the main circuit, forcing the descending elevator to do work in direct proportion to the amount of power given out by the motor, which, by reversal of conditions, has become a dynamo.

Designing an elevator installation demands the consideration of a number of points, among which are the class of travel, distance between floors, available space, labor, and power, heating system (in old buildings), probable ratio of maximum to average load, continuity of service, and legal restrictions.

For example, an apartment-house seven stories high, containing women and children, and in which the service is intermittent and moderate, requires a different type of elevator from that necessary for a transient hotel, which, in turn, has needs differing from those of a loft or office-building.

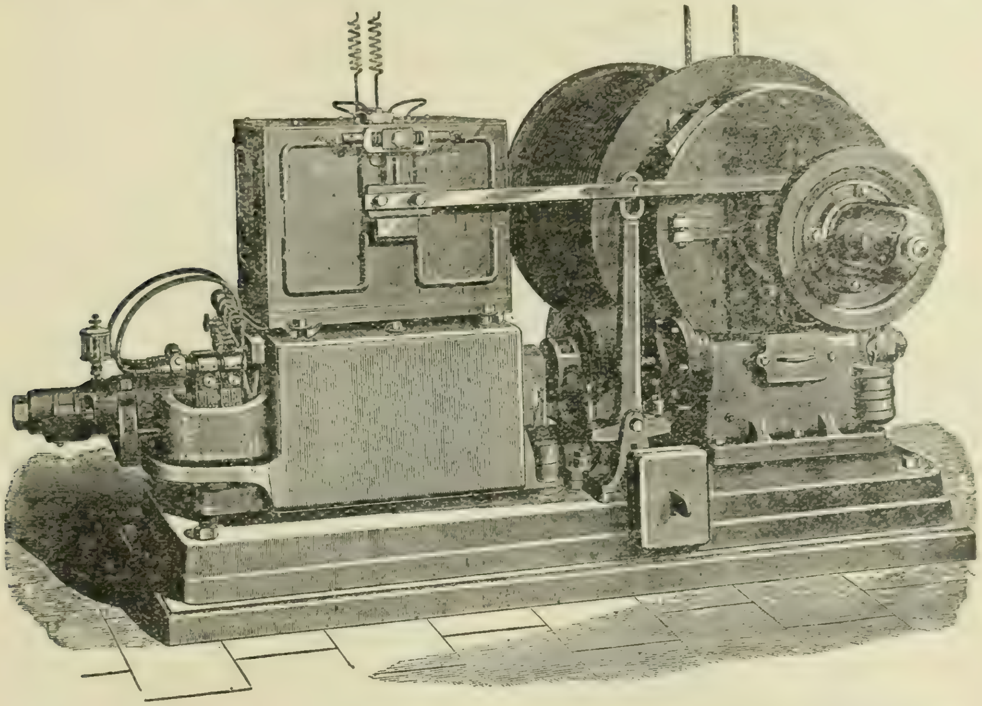
The distance between floors affects the permissible speed without absolutely determining it; a small available space means few cars at high speed with skilled operators; the availability of power from a central station determines, in small buildings, the question of the motive power used; the heating system affects the type of engine or pump employed; the relation of average to maximum load indicates the amount of overbalance, kind of motive power to be used, and the rating of the machinery in h. p.; and continuity of service bears on these points,



ROPE MULTIPLYING GEAR FOR ELECTRIC ELEVATORS.

and on the source, as distinguished from the kind, of power as well. Legal restrictions vary in different communities, but relate generally to questions of safety, and not to the type or kind of machine to be employed.

The question of prime importance in elevator-design is that of safety. Economy of operation and ease of control are large factors, but, no matter what else may have to be sacrificed, human life must be secured. Accidents may occur either from carelessness or from faulty design. The former may be guarded against, but not absolutely prevented; for the latter there is no excuse. A system, to be absolutely safe, should include apparatus for preventing a drop, should all the ropes break at once, or, if one should fail, for preventing abnormal speed due to excessive load or other cause; for holding the car stationary on the removal of power, or under any possible conditions of overload; for absolutely arresting the motion of the hoisting machine, and for removal of power when the car approaches the limits of travel; for immediate removal of power from the hoisting machine in emergency, if the cables slacken or in case of temporary cessation of supply; for receiving and stopping the car and the counterweight, should all the other devices fail to operate; for prevention of operation until hoistway doors are actually closed. The last condition is rarely fulfilled, the automatic house machine being alone in its compliance. Speed is of sufficient importance in the majority of cases to offset the results of possible carelessness on the part of the operator. In addition to the apparatus above mentioned, the cables for hoisting, the safety clutch for gripping the rails, the sheaves, bearing, and, in fact, all vital parts, should be of a strength far in excess of average actual requirements. This strength costs little and is of great importance. Easy, reliable control and economical operation are in a degree opposed, if the fixed charges are included in the latter. An ideally-controlled elevator would be capable of starting the car from rest with uniformly and rapidly accelerated velocity and minimum waste of power, of running the car at varying speeds, and of arresting motion, easily for ordinary stops, and immediately for emergencies. It would be noiseless, simple, and absolutely reliable in its action, and, in case of accident or carelessness of operator, should automatically stop the car. It would be so designed and constructed as to preclude accident, no matter what the operator might attempt to do. These conditions are hard to realize completely in one system, but they have been partly fulfilled by several. Two general methods of control are recognized. The first allows of varying the speed from the car; the second does not, except for starting and stopping. The object of the first method is obtained in two ways: by a pilot motor operating to vary resistance in the main circuit, as in the Sprague system, with an inverse variation of the motor field strength; and the variable voltage, or Leonard, control, where each elevator motor has a separate generator, and the speed of the car changes in accordance with the varying electric pressure of the generator. This pressure is determined by a resistance in series with the small field current, and is adjusted from the car. Both methods meet most of the conditions imposed, and the question of choice for all speeds of less than 350 feet per minute is one of comparative economy. The Leonard system is employed only for worm-gear machines, and could not be operated with the present make of screw and multiple sheave machine. The variable voltage system allows of an ideal start and stop, whether from the standpoint of economy or from that of comfort; on the other hand, from the point of total economy in operation, the rheostat control is advisable because of the necessarily continuous operation, and the first cost of a separate generator for each machine. The proportion of time during which a car is in actual motion varies with the class of travel, but even in ordinary office-buildings it rarely exceeds five-eighths, and generally falls below one-half of the total operating period. In addition, each generator must be of capacity sufficient for the maximum starting load, and consequently runs at low efficiency.



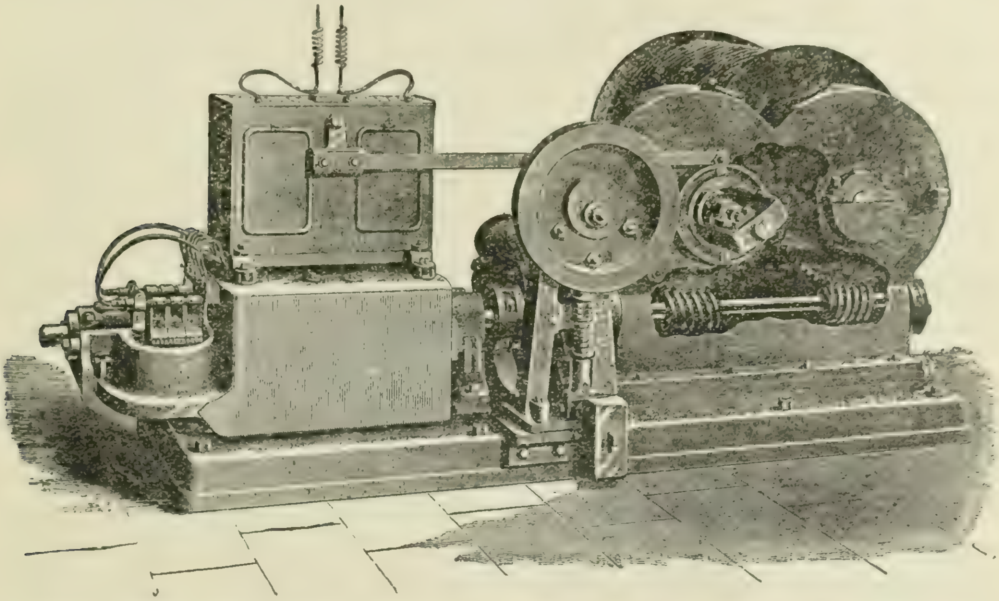
SINGLE WORM-GEAR DRUM ELEVATOR WITH ELECTRO-MECHANICAL CONTROLLER.
Manufactured by Otis Elevator Co.

In this connection the following data from seventeen elevators, taken at random from more than a hundred tests, is of interest. The speed varied from 60 to 450 feet per minute, the maximum capacities from 1,500 pounds to 3,000, the maximum live load was 1,600 pounds, the minimum 150 pounds, and the average only 593 pounds. A test on a tall office-building showed the average load to be less than one-seventh of the maximum, and the figures on another, where the elevators were apparently worked to their fullest capacity, showed it to be less than one-fifth. In general, the average live load varies from one-fifth to one eighth of the maximum. As far as statistics show, the variable voltage system is less economical and simple than the ordinary rheostat control when applied to worm-gear machines; in smoothness of starting and operation it is superior. For low-speed machines, or for buildings where variable speed is not essential, a solenoid control answers all purposes, and its operation may be controlled directly by electricity from the car, or the shipper rope and wheel may be employed to close switches on the machine and operate the brake.

House elevators have an automatic control, which includes the following features: push button, or buttons, on each floor to bring the car to the landing; automatic locks, to prevent opening of the door except when the car is about level with the floor; door switches, stopping the car if door is opened; and a device preventing the operation or calling of the elevator by more than one person at a time. This control works with complete safety and satisfaction with the various parts strongly and mechanically made. Small spring and trigger attachments are to be avoided, positive action, controlled electrically or mechanically, being substituted. Stopping the car is an important branch of the control, and is accomplished by removal of power, brake and short circuiting for heavy loads, and by the first and either of the other two for light loads. The difficulties are apparent; a car must be brought to rest within a few feet under widely-differing conditions of speed and load, and this involves as well the stoppage of the hoisting machine, the counterweight, and the sheaves. For this reason with heavy loads a device compelling the car to do work in stopping is almost a necessity for safe and easy operation. For very-high speed machines still another device is used, which allows the brake band to touch the pulley just before stopping, causing the car to perform direct mechanical work, in addition to the electrical work caused by short circuiting.

The use of a brake depends largely on the construction of the worm gear. If this is of such nature as to allow a loaded car to reverse its motion, a brake is a necessity for holding the elevator in position. If the gear will reverse only when actuated by the motor, the brake becomes an emergency stop, and short circuiting, combined with the friction of the worm, is relied upon for ordinary occasions. This latter method involves the use of a worm gear with a more acute angle of contact, entailing increased friction and decreased efficiency, and requires a larger current for the down start and running. It has, however, an added element of safety.

Correct counterbalancing has an important bearing on the successful operation of the car. Efficiency and ease of running are in a degree opposed. Theoretically that system will be under the best control which has the least inertia ; hence the use of a counterweight tends to reduce the certainty of control, and this result increases with the speed. Practice has shown, however, that, so long as the car exerts one-quarter to one-half more downward force than the counterweight, no trouble need be feared. With the drum machine and a speed of 350 feet a minute or less, two counterweights may be employed, the car counterweight exerting two-thirds as much force as the car unloaded, and the drum counterweight, the ropes of which wind on the drum in an opposite direction to the car ropes, exerting a force equal to that due to the unbalanced weight of the car and to the average load. Where lights or motors are to be supplied from the generators that supply the elevators, the question of economical operation gives precedence to steadiness of pressure, and it may prove advisable to have the counterweight balance one-half the maximum load. In high buildings a varying counterweight must also be



DOUBLE WORM-GEAR DRUM ELEVATOR WITH ELECTRO-MECHANICAL CONTROLLER AND INTERLOCKING WORM-WHEELS.

Manufactured by Otis Elevator Co.

employed to allow for the change in the force exerted by the ropes, as the car moves up and down the shaft, and for the decrease in load in the upper portion of the building. This variable counterweight is a heavy chain, attached at one end to the bottom of the car, and at the other to the counterweight, or to an anchorage in the hoistway. With high-speed service the car should descend by its own weight, and should never be overbalanced. A system involving the opposite principle—*i.e.*, a counterweight exerting a force greater than the car fully loaded—is in use, and should be condemned. The inertia of the system is nearly doubled, and, in case of accident and failure of safeties, the ropes are sure to break with the car at the top, dropping it the whole height of the building. With reduction of inertia in view, the counterweight for high-speed cars moves at only one half or one-third the velocity of the car, the weight being increased in proportion. This reduces the total inertia of the system, and, in addition, decreases the cost of the counterweight guides and ropes.

The proper speed for a given building is one which will enable a trip up or down to be made in half a minute without stops. This figure will be modified to a certain extent by local conditions, but is a rough approximation. Apparently the speed should depend on the number of passengers to be carried, but this varying condition must be met by the size of the car, as there are certain periods of the day when the tenants all move, and high speed is of no advantage. Express elevators to the upper half or third of a tall building have been used with doubtful success. Crowding out of lower-floor tenants is almost prevented, but a number of annoying features have arisen, such as restriction of ease of intercommunication, mistakes in cars, etc. In addition, during all but the "rush" hours two cars are fulfilling the duty of one. Velocity of service is increased by floor calls and indicators showing the position of the cars. Variable speed is a necessity where the cars are required to run at certain distances apart, or where elevators are run from a lighting plant.

For high buildings, with elevators running from 350 to 700 feet per minute, the increase in the inertia of the system and in the probable and possible strains due to sudden stoppage must be met by increased cable strength, fixed and absolute limits of travel, an underbalanced car with a counterweight moving at one-half or one-third its speed, etc. These conditions are filled only by the hydraulic and screw electric machines. The worm-gear drum machine is unfitted for such work, as it has an endless character of movement, and can not have double or triple ropes on the drum, on account of the size of drum necessary and the impossibility of equalizing their work at the machine.

With the screw and ball nut type multiplication of the speed is effected by multiple sheaves on the nut ; the ropes from the last of these sheaves are attached to the bottom of the counterweight. From an anchorage at the top of the shaft other ropes pass around a sheave fastened to the top of the counterweight, and thence over and around the overhead sheaves to the car. Short distances between floors and the necessity for a quick stop indicate probable limits of multiplication. An interval of one second with the screw turning 250 times per minute would carry the car 8⅓ feet in a second, with a multiplication of 20 to 1. The practical limit lies at about these figures, and higher car speed must be obtained by increasing that of the machine. For buildings with elevators running from 150 to 350 feet per minute the double worm-gear drum elevator satisfies all requirements. In this the speed is varied by the ratio of the worm wheel to the worm, and by the size of the drum. Up to a certain limit, with a worm of given size, the greater the ratio, the more economical is the operation of the gear and of the electric motor due to the decreased angle of contact, decreased friction at high speed, and electrical losses. By increasing the diameter of a worm, the path travelled by the point of contact with the wheel is increased, and the angle of contact decreased for a given pitch, rendering a reversal of rotation of the worm by the car more difficult. However, more surface is obtained if the gears are correctly cut and variation in speed and work is more gradual. Consequently heavy loads require large worms. The limit of multiplication is fixed by the size of the drum, which, in turn, is determined largely by the height of the hoistway, and in some cases by the space allotted to the elevator machinery. For residences, apartment-houses, and sidewalk hoists, requiring speeds of 150 feet per minute or less, the single worm-gear drum is used exclusively, and is operated by a solenoid or by automatic control. As these machines receive little or no care, they must be simple and automatic in their action, and at the same time be capable of receiving bad treatment without injury : hence self-oiling bearings, self-cleaning switches, enclosed motors and parts, and magnetic blow-outs or other arc arresters are desirable. Where the car is run but seldom, it may be advisable to counterweight for one-half the maximum load, in order to decrease first cost of the motor ; but the question is not of importance. The requirements of the motors for all the three types are strength, sparkless commutation with all loads and speeds, ventilated armatures, careful securing of lugs, commutator bars, and winding, and avoidance of sharp corners, fields variable and balanced, etc. Devices for opening and closing the circuit without destructive arcing involve either the magnetic blow-out or the divided arc principle for all heavy work. For light loads a quick, long break answers all purposes. In general, high speed is not advisable or essential. The hoistway should be of a fire-proof material and covered by a skylight, with a screen placed immediately below the overhead machinery. Ample room above and below the car at its limits of travel, to provide for possible slip or stretch in the ropes, should be allowed. If grill work is used, a simple, open pattern, giving a clear view of the landings, is most satisfactory to the operator, and may be made entirely safe.

Operation of elevators from the lighting engine is frequently desirable ; with overbalanced machines carrying moderate loads this can be accomplished by adopting a slow starting device or by running the generator below its rated output. In either case, even with perfect engine-regulation, a flicker in the lights will occur, due to the electrical reaction of the varying current. With underbalanced machines the flicker is more noticeable and can be removed only by the employment of a separate generator for power—coupled or belted to the lighting engine, or by the use of storage batteries in connection with a booste motor-dynamo.

Where a number of worm-gear elevators are installed, a large economy results from the balancing action of the descending elevators, which return current to the source, aiding those ascending.

The cost of electric-elevator operation is lower than that of any other practical method. The power required per car-mile in office-buildings varies from 2 kilowatt hours (with the overbalanced worm gear) to 4 kilowatt hours (with the underbalanced screw). Approximate costs on the central service at 10 cents per h.-p. hour for small, and 10 cents per kilowatt hour for large, consumers are $3 to $10 for residences, $10 to $20 for apartment-houses, $15 to $40 for loft and small office-buildings, and $40 to $90 for tall office-buildings, per month.

In conclusion, an answer to the question so often advanced : "Are electric elevators safe and reliable?" will not be unfitting. Electric elevators are the safest vehicles to travel in known to humanity ; none have ever fallen, nor have people been killed by them except through their own carelessness,—a remarkable record considering the novelty and number of machines installed. Like the motor of the trolley car, they run in positions apparently ruinous to fine machinery—such as buildings half completed and damp holes,—without serious damage ; they require but little attention, oiling and cleaning being necessary only once or twice a day, and are highly efficient.

REVIEW OF THE ENGINEERING PRESS

CONTENTS.

ARCHITECTURE AND BUILDING.

Esthetics of Bridge Design 494
National Style in Architecture 501

CIVIL ENGINEERING.

The Hemet Dam 497
An Important Bridge Replacement...... 500
The Colombo Harbor Works..... 507
Improvements at the Mouth of the Loire . 509
Recent German Bridges................ 513
The Eckmühl Lighthouse 514
The Caissons of the Alexander III Bridge 515

ECONOMICS AND INDUSTRY.

Labor-Saving Machinery............... 501
Technical Education and Foreign Competition 504
The Stockholm Exposition.............. 510
Old Paper 511

ELECTRICAL ENGINEERING.

Electricity as a Source of Heat.......... 497
The Equalization of Electrical Energy... 499

MARINE ENGINEERING.

The Speed Trials of the Powerful 502

MECHANICAL ENGINEERING.

Steam Boiler Efficiency 496
The Sand Blast for Cleaning Metal...... 500
Wire-Drawn Steam................. .. 503
Mechanical Recording Apparatus........ 516

MINING AND METALLURGY.

Gold Placers and Lodes........... . .. 495
The Ventilation of Mines............... 508
Chinese Mining Communities.... 510
Portable Bulkheads for Mines........... 514

MUNICIPAL ENGINEERING.

Garbage Disposal 493
Gas and Electricity.................... 503
Paris Sewer Construction............... 512

RAILROAD AFFAIRS.

Historical Locomotives 495
The Federal Coupler Law.............. 498
Railroad Building in South Africa....... 505

STREET AND ELECTRIC RAILWAYS.

Electricity on the London Underground .. 506

Garbage Disposal.

THE interest which attaches at the present time to the question of the complete and economical disposition of garbage renders every reliable account of successful practice important, either for purpose of comparison or of imitation, and hence the very complete paper upon the garbage disposal works at Hamburg, by Mr. Rudolph Hering in the *Engineering Record* (October 23), is to be welcomed, especially as this is the largest single plant in any city up to the present time.

It is now one year since these works have been in operation, and the careful records which have been kept enable definite information to be obtained concerning the operative and financial success attained.

The plant is designed to provide for the incineration of the garbage and refuse from a population of 300,000 persons, and, after some consideration, it was decided to use furnaces of the Horsfall, Warner, and Whiley systems, following generally the English designs, with some modifications due to local conditions. As the Horsfall and the Warner furnaces were to be used in a similar plant at Berlin, the Warner furnace was replaced by the Whiley system at Hamburg. The Horsfall cells were arranged for hand-firing, with steam jet blast under the grates, while the Whiley system included moving grates, by which the drying and burning refuse was to be moved forward automatically. In practice, however, it has been found better to substitute air blast in the one case for steam, and hand-stoking for automatic action in the other, and with these modifications the plant has been operated since April, 1896.

The general arrangement of the plant is very fully shown in Mr. Hering's article, together with the electric cranes by which the iron tank bodies of the collecting carts are handled and the garbage dumped at the furnaces. There are thirty-six furnaces, or cells, arranged in two rows, so that either half of the plant can be used separately, one tall chimney answering for both sets of furnaces. The natural draft of the chimney is aided by an undergrate air-blower, and, after the combustion is started, no coal is required to assist in the complete incineration of the refuse. An auxiliary grate-furnace for coal is provided to get up steam in the boilers and start the blowers, after which all the heat for the generation of steam necessary for the operation of the blast, and the production of electricity for the cranes and for lighting is produced by the combustion of the garbage.

The clinker and ash produced in the furnaces is cooled, broken and crushed, and sold for road-making and for the manufacture of concrete slabs, the demand thus far exceeding the supply.

The works have proved entirely unobjectionable to the surrounding neighborhood, no offensive smoke or odors being produced. The cost of the entire plant is given as $120,000, the capacity being 78,876 metric tons per year of 313 working days. Taking into account interest on cost, and also sinking fund and maintenance, and deducting for sale of refuse, the cost for the past year has been 35 cents per metric ton (practically an English long ton), and, when the preparations for fully utilizing the heat are completed, this will be reduced to 21 cents per ton.

Mr. Hering's paper is full of valuable detailed information, which cannot fail to be of much use in the United States.

The Esthetics of Bridge-Design.

THE charge has often been made that engineering works are in themselves ugly, and very often are made still more unsightly by clumsy attempts to decorate them. It is, however, by no means the fact that utility and ugliness are necessarily companions, and a well-proportioned structure may contain within its own lines the elements of beauty to almost as great an extent as does an architectural masterpiece.

Mr. Alfred P. Boller, the well-known engineer, has contributed to *Engineering News* (October 7) an article upon the subject of the esthetics of bridge-design, choosing as texts, so to speak, for his discourse two bridges recently completed in New York city; incidentally he brings out many points which need emphasizing so far as many other engineering structures are concerned. As Mr. Boller truly says, "the splendor of a city is made by its architecture in the broadest sense of the term, which is its outward and visible form, and, when there are waterways demanding bridge crossings, such crossings should be studied on architectural principles, as well as those of purely constructive engineering."

After defining good architecture under the three ultimate heads of fitness, stability, and beauty, Mr. Boller notes that the first two of these are essentially engineering demands, and must necessarily appear in engineering structures, but that the last requires for its realization an entirely different mental equipment, involving both a familiarity with admitted types of pleasing and attractive forms, and an appreciation of the thought behind them and their underlying principles.

While there are no empirical rules for beauty, there is yet an intuitive development of public taste based upon contact and association with the works of great designers, and the principles beneath all really artistic designs apply as well to bridges as to other structures. Applied ornament has its place, as in general architecture, and should be used most sparingly, the best rule being the old saying: "Decorate construction, but do not construct decoration."

This is especially true of bridges, which, as a rule, are seen at a distance, and to which character is given by mass and general proportions. It is only under close inspection, when the effect of the whole is lost, that detail can be grasped, "but the lines and masses, the relations of the units to each other, such as proportions of piers and spans, down to subordinate relations of railing and cornice, are what give character to such structures."

The ideal basis for a beautiful structure is the arch, whether in thrust or in tension, and it should always be adopted when artistic effect is demanded and structural conditions will permit. On important waterways, however, the use of the arch is rarely possible, and girder forms must be adopted as constructive necessities, usually also with draw or swing spans.

In both of the bridges reviewed by Mr. Boller, the latter form was of necessity adopted, and in both he has endeavored to embody the principles of architectural bridge-design on the lines indicated in his article. While the limitations of construction hampered the artistic side of the work materially, there is no doubt that both the Ship Canal bridge and the Central bridge over the Harlem, of which illustrations are given in *Engineering News*, show abundant evidence of earnest effort to raise the art of the bridge-builder to a higher plane than that of a mere constructor, and a fair measure of realization of the true artistic combination of fitness, stability, and beauty.

Gold Placers and Lodes.

THE richness of the Alaskan gold placers has led to some discussion as to the possibility of the discovery of the lodes from which presumably the placer gold has been eroded, and in this connection the *Engineering and Mining Journal* (October 16) gives some valuable remarks about the relations of placers and lodes, which are very pertinent at the present time.

It is generally assumed that rich placers mean rich lodes somewhere behind them, and that exploration will reveal the sources of the gold in even greater quantity than the gravel and alluvial deposits of the streams and valleys. This, however, is not necessarily the case. It is true that a placer is a natural concentration of mineral which once existed in solid rock, but this concentration may have originated in many veinlets so small as to be unworkable in themselves, or the parent lode may have been eroded entirely, and be no longer in existence.

Sometimes also the auriferous *débris* have been carried so far, by glacial action, that no connection between placer and lode can be established.

These views are supported by the history of some famous placers, those of Breckenridge, Colo., of Leadville, of the American river, in California, and others, being cited to show that, when the veins were successfully traced from the placers, the resulting quartz mines were by no means so rich as might have been inferred.

The reverse has also yet to be established,—*viz.*, that placers of value should accompany rich lodes,—and in the cases of the great quartz veins of Grass Valley, Nevada City, and the rest of the Mother Lode no placers of great importance were found.

In concluding, the writer applies existing experience to the Klondike placers as follows;

"Although the evidence of direct connection between the richest placers and the richest lodes is largely negative, it does not follow that where the former are found the latter should not be looked for, and the fact remains that the two classes of deposits commonly occur in the same region. There is much reason to expect, therefore, that many lodes will be found, sooner or later, in the Yukon country, but their discovery may not be so simple a matter as is supposed by many who seem to believe that all that is necessary is to follow the gold-bearing creeks to their heads to find the mother lodes from which the alluvial deposits have sprung out."

Historical Locomotives.

THOSE who had the privilege of inspecting the notable exhibit of the Baltimore & Ohio Railroad Company at Chicago in 1893 then realized what an interesting place in mechanical history was filled by that array of locomotives of successive periods and builders.

The *Railroad Gazette* (October 22) now calls attention to the fact that this important exhibit of full-size models and actual engines forms the nucleus of the still more complete collection in the Field Columbian Museum, at Chicago. Many of these engines are but models, reproduced from old drawings, fragments, and other data, but there are not less than fifteen original locomotives of the types used between 1832 and 1876, and the collection far surpasses in completeness and value the one at South Kensington Museum in London.

The Field Museum also contains the very valuable collection of drawings, tracings, and sketches of locomotives made in England, these having been acquired by the energetic efforts of the Baltimore & Ohio officials in 1893. These contain many originals of engines built by Stephenson, Bury, and others, and at present no such collection exists anywhere else in the world.

As the *Railroad Gazette* remarks, "we have a more complete set of drawings of historical English engines than can be found in any one place in England, so that, if Englishmen wish to know the full locomotive history of their country, they will have to journey to Chicago for the information."

Steam-Boiler Efficiency.

THERE is a growing disposition on the part both of engineers and of manufacturers to demand efficiency tests of steam-boilers, and performances on this basis are frequently demanded in specifications. Under these circumstances the question of the exact meaning of the term "efficiency." as applied to a steam-boiler, is a matter of importance, and its definition should be clearly understood.

A paper by Mr. V. C. Gasche, read before the Western Society of Engineers, and published in the *Transactions* of that Society (August, 1897), discusses at some length the causes of the variable efficiency of steam-boilers and their influence upon tests, and shows the lack of definiteness in the present usage of the term efficiency.

Usually the "efficiency" of a steam-boiler is considered to be the ratio of the actual to the theoretical evaporation, the theoretical evaporation being understood to mean that which would have been attained had all the heat generated by the complete combustion of the fuel been transferred to the water and the steam. Another, and more recent, definition of the efficiency of a steam generator is the ratio of the heat units absorbed to the total heat equivalent of the fuel expressed in British thermal units.

These both seem definite enough, and, in view of the precision with which all the data of a modern boiler test are taken, should apparently give the determination of the efficiency of a given boiler a high degree of accuracy. In practice, however, successive trials often show remarkable variations of efficiency, though boiler, fuel, and surrounding conditions are the same. The cause of these variations Mr. Gasche finds in the influence of the rate of combustion of the fuel. The thermal unit is undoubtedly a constant quantity, but the variable resistance of materials to the transfer of heat introduces the time element.

Mr. Gasche very correctly insists that a boiler trial is essentially a measurement of rates.

"The ultimate result depends on rate of delivery, of feed water, rate of coal consumption, and rate of ejection of moisture with the steam. The first requisite for the measurement of these rates is to maintain constant the conditions upon which the operation of the boiler depends, meaning, among other things, that the demands for steam from a boiler under test must be maintained as nearly uniform as it is possible to make them."

By means of diagrams plotted from data of various boiler tests, it is shown that Rankine's analytical formula for the determination of efficiency from given conditions expresses the law of variation of boiler efficiency, and, by comparison between the computed evaporation and the actual determinations from sixteen typical boiler trials selected from one hundred and sixty tests, the important influence of the rate of combustion upon the efficiency is shown.

It is most undoubtedly desirable to maintain all conditions as nearly uniform as possible during a boiler test, and the especial importance of the uniformity in the rate of combustion is well brought out in this paper. The flying start and finish, even though involving an estimate of the difference in the quality of coal on the grate at the beginning and end of the trial, appears to permit a more uniform maintenance of rate of combustion than is possible by withdrawing the fuel on the grate and making a fresh start. A similar occasion for variation appears in the practice of allowing the fires to burn out at the close of the trial.

In view of the possible sources of variation of efficiency in the performance of the same boiler when the conditions of combustion are varied, it certainly seems advisable that the same conditions should be observed, so far as possible, in comparative tests of boilers of different construction, and Mr. Gasche has done well in calling attention to the sources of discrepancy.

Electricity as a Source of Heat.

MONTREAL is now supplied with electric current from two natural sources of power, one operated by the Chambly Manufacturing Company and utilizing the rapids of the Richelieu river, the other being the great power plant of the Lachine rapids on the St. Lawrence. To describe either in detail would be but to repeat accounts of turbines, generators, and transmission which have already appeared in other places, notably in the *Electrical World* (October 2 and 9); but some of the especial points of interest may be noted here.

Two features of discussion in the Montreal plant are somewhat local and climatic; one the problem of coping with the anchor ice and gorges; the other the proposition to use electric current generally as a source of heat. Of course, electric heating is, in itself, nothing new; but at Montreal it is seriously proposed by the electric company to attempt to compete with anthracite coal in the matter of domestic heating. Coal for household purposes at Montreal costs six dollars a ton, and it is claimed that the cheapness with which current can be obtained will permit electricity to be used for cooking and warming, through the Canadian winter, advantageously, as compared with fuel.

In an editorial in the *Electrical World* the computation of the equivalent cost per heat unit, with coal at six dollars per ton, is made as follows:

"A theoretical determination of the heat obtainable from coal and from electrical energy indicates that the rate per kilowatt-hour will have to be made extremely low to compete with coal at such a price. Anthracite coal gives off, in burning, approximately 15,000 British thermal units per pound. Allowing for a loss of 50 per cent. from incomplete combustion and flue losses, electrical energy would have to be sold at the rate of fifteen one-hundredths of one cent per kilowatt-hour to make the cost per heat unit the same as that derived from six-dollar coal."

Should this experiment, made on so large a scale and in so exacting a climate, prove successful, it will doubtless encourage other attempts to convert hydraulic into thermal energy, the more so when it is remembered that some of the greatest sources of water power are found in localities in which fuel is both scarce and dear.

The Hemet Dam.

THE subject of the design and construction of masonry dams is one which at the present time is receiving renewed attention, and this for several reasons. In one part of the United States water is being impounded for purposes of irrigation; in another, water power is applied to the economical generation of electricity; while, on both sides of the ocean, the disastrous failure of large dams, releasing enormous volumes of water, has caused active discussion as to questions of detail in form and construction, both as regards safety and economy.

California contains a large number of important high masonry dams of recent construction, and one of the most important of these, the Hemet Dam, is very fully described by Mr. James D. Schuyler, by whom it was planned and supervised, in a paper read before the Technical Society of the Pacific Coast, and published in the *Journal of the Association of Engineering Sociéties* (September, 1897).

The Hemet dam is noteworthy both on account of its height, 122.5 feet, with a possible extension to 150 feet, and for the care given to its design. The general theory of dam construction includes two forms,—the arch, and the gravity form. One of the most important California dams, the famous Bear Valley Dam, depends wholly upon its arch form for its stability, and it was at first proposed to construct the Hemet dam of a uniform thickness of four feet, with an arch curvature up stream of the shortest possible radius. Fortunately, however, wiser counsels prevailed, and the present dam combines both the arch form and a profile of the gravity type, thus possessing the advantages of both forms. This construction was the more practicable because of the favorable nature of the location, the dam being situated at the head of a narrow granite cañon, with solid bed-rock foundation, with abundance of sand and rock for construction at hand, the cement being the only material brought from a distance.

The methods used in the construction work were modern and effective, two cableways being used to handle the heavy blocks of stone, taking them from the banks and delivering them to derricks mounted on the dam. The power for hoisting and handling was obtained from a Pelton wheel driven by water brought in a temporary flume, the stream thus being compelled to work its own confinement; and the same power was used to operate the mortar and concrete mixers. Rock-crushers and -conveyors were also used in the preparation of the concrete, and the general plant was so arranged that unskilled laborers were able to perform most of the work.

The dam is 100 feet thick at the base, and 30 feet thick at a point 110 feet above the base, at which point the wall is reduced to 12 feet. The profile is so drawn that the line of pressure with full reservoir falls just outside the inner third of the base at all points, thus conforming to the theoretical requirements for stability, while the additional strength due to the curved shape gives a still greater measure of security. Another important point in favor of the curved shape, urged by Mr. Schuyler, is that advanced by Professor Forchheimer, as to the ability of a curved dam to permit the motion due to expansion and contraction from temperature and shrinkage, without the formation of cracks. Unless some such provision is made, a tension stress greater than the cement is capable of resisting may be brought upon the masonry, altogether independently of the hydrostatic action.

The reservoir formed by the Hemet dam, as at present completed to the 122.5 height, has a capacity of 10,500 acre-feet, or 3,430,000,000 gallons, and, by carrying the dam to the 150-foot contour, this would be increased nearly two and a half times. At its present capacity the reservoir is capable of providing sufficient water for the irrigation of 5,250 acres.

In view of the increasing importance of dam construction in various localities, Mr. Schuyler's paper is of much value, and should be consulted by all interested as a record of a work of great magnitude and importance.

The Federal Coupler Law.

UNLESS relief or extension of time is granted by the interstate commission, all the railroads of the country must have their freight cars equipped with automatic couplers by January 1, 1898; and in the *Railroad Gazette* (October 15) is an editorial reviewing the progress which various railroads have made in preparing for compliance with the law.

During the past three years the business depression has made it somewhat onerous for many roads to incur the expense involved in the equipment, and, according to a table issued by the interstate commission, but few roads have all their freight cars fitted with couplers as required by law. There has been much progress made, however, and, although not many are entirely equipped, a number of roads have more than 75 per cent. of their cars provided with automatic couplers.

It is interesting to note that the roads which have more nearly placed their equipment in condition to comply with the law by the first of the year are in many cases those of the poorer companies, while many which are good dividend-payers are by no means so far advanced. It is understood that, in applications for an extension of time, each case will be heard on its merits, and no general extension for all roads is to be granted; hence, although the work will not be completed by January 1, the coming year should certainly see hand-coupling of freight cars practically a thing of the past.

Another requirement of the law is that of providing all freight trains with sufficient train-brake equipment to permit the speed to be controlled by the engineman. In this respect the progress of the roads, with few exceptions, has been less satisfactory than in the matter of couplers.

The full compliance with all the requirements of the law should certainly result in great reduction in loss of life and in injuries to train hands, and the final outcome should also be beneficial to the companies from a purely commercial standpoint, when the economy resulting from better and more efficient control shall appear.

The Equalization of Electrical Energy.

STORAGE batteries have been used to a much greater extent in Germany than in the United States for the purpose of equalizing the demands upon generators of electrical energy, this especially being the case in tramway service, where the fluctuations in traffic during different portions of the day are very great. The advantages of this use of accumulators is beginning to be realized more generally, and the storage battery forms a very important portion of the new Hartford Electric Light and Power Plant, described in the *Scientific American* (October 9).

The Hartford plant is a remarkably good instance of the flexibility and controllability of an electrical system. A portion of the current is generated by the water power of the Farmington river, the dam being nearly eleven miles from Hartford. Sixteen hundred horse power is thus obtained, and, after being transformed from 500 to 10,000 volts, is transmitted to the Pearl street station in Hartford at a loss of only about 10 per cent. At this station there is also a 1,600-h. p. Corliss engine, coupled to a 600-kilowatt Westinghouse generator, the engine and generator being connected to opposite ends of a main driving shaft, from which also belts are run to the arc dynamos and the street-railway generators. The 10,000-volt current is reduced here to 2,400 volts, and supplies the alternating light and power system of the city, and is also transmitted to the rotary transformers at the State street station. So much of the current as is not required for these purposes operates, as a motor, the 600-kilowatt machine which is coupled to the end of the line shaft, this being so constructed as to be immediately available, either as a motor or as a generator.

At the State street station is the great storage battery, said to be the largest in the United States, and here the 2,400-volt alternating current is received by rotary transformers and delivered into the storage battery as a 240-volt direct current.

The storage battery contains 130 cells, each containing 31 negative and 30 positive plates, the negative plates being of the chlorid type and the positive plates of the Manchester type of Planté plate. Its capacity is a discharge of 1,700 amperes on each side for five hours.

The results of the general arrangement of the Hartford plant are best shown by the load diagram of the State street station. During the early morning hours the consumption of current is only about 350 amperes, the balance being discharged into the battery for subsequent use. When the heavy demand comes, between 6 and 8.30 A. M., the entire transformer current is required on the lines, while later in the day, until the night demand for light ceases, the lines draw all of their current from the battery, after which the charging of the battery again commences, and the current for the line is drawn from the transformers.

The application of the storage battery for this purpose of equalization is a valuable method of overcoming the irregularity of demand upon an electrical station, either for light or power, and the successful working of the Hartford plant should lead to further installations of a similar character.

An Important Bridge Replacement.

THE Pennsylvania Railroad Company has for some time been engaged in adapting various portions of its system to the increased demands of traffic, including the greater weight of engines and rolling stock which has gradually come into use. One of the most important pieces of work in this connection was that of the replacement of the bridge of the New York division over the Schuylkill river at Philadelphia, commonly known as the "connecting bridge."

An excellent account of this skilfully-executed piece of engineering work is given in *Engineering News* (October 21), and the success with which a double-track span of 236 feet was replaced in a few minutes renders the account of much value and interest.

Owing to the elevation of the tracks at this point, some eighty-seven feet above the river, and the unreliable nature of the bottom, it was not considered advisable to construct a temporary turnout bridge, but, instead, the new truss was assembled entire upon false works by the side of the old truss and additional false works were constructed on the other side to receive the old bridge. Both spans were then moved horizontally in a direction transverse to the line of the tracks, during an interval between trains, there being thus no interruption to travel.

By the use of suitable piling, the masonry bridge seat at each pier was provided with a timber extension on both sides, and a system of bed-plates and rollers permitted the transfer of the trusses with no difficulty or delay. So completely had all preparations been made that the actual time occupied in changing spans was only 2 minutes 30 seconds, and the actual time between the last train over the old span and the first over the new span was but 14 minutes.

The new bridge consists of two deck Pratt trusses, the span being 235 feet 7 inches and the depth 25 feet 9 inches. It is a most substantial structure. The old truss was of the Whipple pattern, and was built in 1865, and, although it had been maintained in good condition, it was antiquated in design and unsuited for the increased service. The weight of the new truss is 570 tons, and the total weight to be moved during the transfer, including the old truss, rails, ties, and guards, was about 1,400 tons.

The operation reflects much credit upon the builders, the Edgemoor Bridge Co., and upon the engineering department of the railroad company, by which the transfer was conducted. The method may be adopted in subsequent operations of a similar nature.

The Sand Blast for Cleaning Metal.

THE use of the Tilghman sand blast for cleaning the steel viaduct at One hundred and fifty-fifth street, New York, preparatory to painting, as described in *American Machinist* (September 30), is an application on a large scale of what has been in use in a smaller way for many years. In the treatment of metal by the Bower-Barff process, the continuity of the film of magnetic oxid of iron can be assured only by exposing an absolutely clean surface to the action of the gases. For this purpose the sand blast has been found most efficient, and its action prepares the iron pieces for the oxidizing furnace with a completeness not otherwise possible. The effect upon the appearance of the metal is well described in the article above referred to, the silvery gray color being characteristic; and it is to the action of the sand blast also that the peculiar smooth and velvety touch of Bower-Barff hardware is due.

Doubtless the success of this application of the sand blast for cleaning structural work will be followed by its extension to other lines, and, in view of its long use for smaller work, it is a matter for surprise that the process has not long been used for general metal-cleaning.

THE BRITISH PRESS

National Style in Architecture.

IN the course of the president's address at the Liverpool Architectural Society, the speaker, Mr. W. E. Willink, utters some wise and wholesome truths, of which we have space only for a brief abstract. The entire address will be found in the *Builder* (October 9), and is well worth reading.

After deploring the lack of national style in most modern work, and discussing the vast difference between medieval work, in which all the influences of the time found immediate expression in art and architecture, and modern work, in which some past style is copied or imitated, Mr. Willink compares the French method of censorship with the English freedom.

Where, as in France, there is practically a tribunal of art, there will doubtless be produced a national style, which can be and is polished to an extraordinary degree of refinement. "The points of difference are less marked than the points of resemblance; man can be measured against man by the application of standards which admit of no contradiction."

In England, on the contrary, there is such reverence for liberty that no such interference would be tolerated, and the result is what might almost be termed architectural license. So far as immediate results are concerned, there is little doubt that the introduction of the French method would result in marked improvement, but in the long run there would be, as in France, the great danger that the style would become fossilized, and all life chilled out of the artist. With entire liberty, however, Mr. Willink sees greater future results, both for England and America, in the final outcome of national style:

"Men will rise up, who, though well instructed in all the wisdom of the ancients, are enabled, by their force of character, and the instinct of the true prophet, to seize the various films and threads of truth which are floating at large through the air of design, and weave them into a tissue of beauty and fitness which will recommend itself to the world as that which past generations have longed to see, and still desired when they left the scene. And there are signs of the near approach of this great change. There are now vigorous designers who have thrown away the shell of form and kept the kernel, whose conceptions may shock at first by their originality and daring, but finally please by their conformity with fundamental canons. These men I firmly believe to be the forerunners of a new method of expression, which in its many forms (for we need not fear uniformity in this country) will command the adhesion of all who truly love and appreciate the beautiful."

Labor-Saving Machinery.

THE great dispute in England between the Amalgamated Society of Engineers and the Employers' Federation concerns not only the hours of labor, but also involves the question of the control of machines, and indirectly of the nature of the machines themselves.

This side of the subject is well brought out in an editorial in *Engineering* (October 1), and is of especial interest in this connection, since it emphasizes the great difference between English and American methods, and calls attention to modern automatic machinery and to the methods of operation as well.

The revolution which the introduction of power machinery wrought in manufacturing, and the opposition excited among the workingmen at that time, are matters of history, and the riots of "General" Ludd and his machinery-breakers in the early part of the century were but an expression of the fear of the man for the machine which has appeared again and again at many times and in many places.

To the labor union, the idea of labor is based upon the output which a skilled mechanic can produce with the ordinary tools of his trade that have been in vogue for a number of years, and, as this output is mainly proportional to time, the time-rate of wages and the established working-day are taken as a just measure of the wages to be paid. For non-repetition work, tool-making, repair jobs, and the like, this will probably remain true for a long time, but, in the case of duplicate work, the evolution, not only of special tools, but also of automatic machines, which, within certain limits, can be made special tools, has totally changed the relation between the man and the product. From being a skilled hand-artisan, the man becomes a machine-tender,—almost a mere "stopper and starter,"—while the relation of time to output is entirely altered by the fact that one man can attend a number of machines with decidedly less exertion than the old method involved in the same time, and the speed of operation and perfection of product are vastly greater than before.

What is to be done under this new state of affairs? We have only to look back a little to see that it is not really a new state of affairs, but only a new statement of an old problem, which has worked out its own solution many times before.

It has not always been the workingman who has felt the inconvenient pressure wrought by the development of the mechanical application of inventive genius. The trained knight whose whole life had been given to the skilled profession of arms made a mighty uproar when "villainous saltpeter" placed in the hands of the veriest peasant the power to lay him low, in spite of all rules and precedents. So, too, the monkish penman found all his occupation and most of his power wrested from him by the printer mechanic, untrained according to all custom and theory, but nevertheless most irresistible. But it is unnecessary to rehearse what is too well known already. The laws of evolution hold true in one direction as well as another, and opposition to labor-saving machinery is as futile to-day as it ever has been. The countries with which England must compete—Germany, Belgium, the United States—have accepted the situation; for England to refuse, or even to hesitate too long, means industrial suicide.

As for the mechanic himself, history too must tell him what to do. Has his case been helped or harmed in the past by labor-saving machinery? At first much hardship has been wrought, but in the long run we see more men at work, with better wages and shorter hours. History repeats itself in more ways than one.

Speed Trials of the "Powerful."

THE cruiser Powerful of which illustrations are given in one of the leading articles in this issue, has been put through a series of interesting progressive speed trials in Stokes bay, preparatory to her departure for China, where she is to be stationed, and from a report in *Engineering* (October 15) we abstract the following final data of her performance. These figures, the means of four runs each, furnish valuable data for the construction of a speed curve from which the power required for intermediate speeds may be determined, and the performance is especially interesting in view of the fact that this vessel and her sister ship, the Terrible, are fitted with Belleville water-tube boilers, being the first cruisers of the first-class to be so equipped.

The following table gives the indicated power and logged speed on the successive trials:

Speed of Vessel, Knots	10.591	12.492	14.223	16.206	20.96	22
Indicated Horse Power	2256	3735	5452	8344	18,677	24,763

The displacement at the normal loaded draught of 27 feet is 14,250 tons.

The Powerful is also interesting as being one of the two first-class cruisers to be fitted with water-tube boilers, the Belleville type being used. Details of these boilers are given in the article on water-tube boilers by P. A. Engr. W. M. McFarland, U. S. N., elsewhere in this issue.

The adoption of water-tube boilers for the Powerful and her twin-ship, the Terrible, was the cause of a very animated parliamentary discussion at the time, but the trials have fully confirmed the wisdom of the course, and the results will doubtless lead to the use of water-tube boilers in larger units and for larger vessels, not only in the British navy, but elsewhere.

Gas and Electricity.

About the year 1877, when the introduction of electricity for household and general lighting became a commercial fact, the well-known "scare" in gas stocks occurred, and for a time it seemed as if much valuable property represented by gas shares had been almost wiped out. Notwithstanding the great development in electricity during the twenty years following, the gas industry to-day is more prosperous than ever, and it seems more than ever as if there was ample room for both gas and electricity, side by side, in widely-varying lines of application.

An interesting review of the progress of gas and electricity is given in the address of Mr. Holliday at the Scarborough meeting of the North of England Gas Managers' Association, printed in the *Journal of Gas Lighting* (October 5). The general progress of gas is shown by a diagram of the varying prices of a provincial gas company between the years 1872–1896, the drop in 1877–78 being well marked and the ups and downs of the stock from 1882 onward being along a generally ascending line, until in 1895 public sales of shares gave a price of 175 as against 143 in 1877 and 125 in 1882. During this entire time the regular dividends had been paid, and the fluctuations and the recovery occurred in the face of the great and steady advance in electric lighting.

Much of this recovery doubtless is due to the use of gas for heating and cooking, and of late also to the improvements in incandescent gas-lighting. The increase in the day-consumption of gas is an excellent indication of the growing use for heat surposes, and the Scarborough tables for July and August show that the day-consumption reached 45 per cent. of the total output of the local gas works. In the field of illumination Mr. Holliday concedes the present superiority of electricity, notwithstanding the advance made by the Welsbach type of burner, and makes a strong plea for improvement in methods of lighting by gas before this field is entirely lost.

Speaking of the progress already made with incandescent burners, Mr. Holliday proceeds: "There is still much to be done to get a burner which will meet the views of consumers as a body. It appears to me that what we really require is a medium capable of resisting a greater amount of wear and tear than the mantles at present on the market,—that is to say, something approaching the hardness and durability of an ordinary flat flame or argand burner at least, and one which will develop high luminous effects with a low standard of gas. If such a burner could be placed upon the market at a very low figure and its use become universal, the amount of money which could be saved in most cases by supplying a gas of lower illuminating power would enable us to charge such a price for the gas as would render its position, even as an illuminant, almost unassailable."

Wire-Drawn Steam.

Many years ago the relative economy of wire-drawing and expansion in the cylinder was a question much discussed, and comparative experiments were made to settle the doubtful point. The results appeared to favor so strongly the use of steam at the highest initial pressure expanded in the cylinder that throttling was relegated to second place, and expansion, either automatic or variable, was considered the correct practice.

The matter is not settled, however, to the satisfaction of all concerned, and an editorial in *The Engineer* (October 1) reopens the discussion with some points worthy of serious consideration, especially in view of modern conditions. The tests referred to, given in Murray's "Treatise on the Marine Engine," in 1858, were made with only eight pounds, pressure in the boiler, and the meager data concerning many important details leave us in doubt as to the actual reliability of the results.

The general consideration given in recent years to the large losses due to cylinder condensation has led to a decided leaning toward superheating, and Rankine long ago showed the effectiveness of wire-drawing as a means of superheating, as well as of definitely controlling the degree of superheat thus obtainable.

Now, with the modern water-tube boilers a decidedly higher pressure can be safely maintained than is really required in the cylinder, and it is not impossible that better results would be obtained by maintaining a pressure, say, of 250 pounds in the boiler, and throttling this to 180 or 160 pounds for use expansively in the engine. The steam thus delivered to the engine would have the excess temperature due to the pressure at the boiler, and the expansion could be carried on in the cylinder as far as would have been thought advisable with an initial pressure of 160 to 180 pounds, besides having the excess temperature to counteract cylinder condensation.

A direct advantage is also gained by the greater ease with which wire-drawing permits a steady pressure to be maintained in the boilers, the higher boiler pressure practically corresponding to proportionally-increased steam-room; and the fluctuations in the demand for steam by the engine are much less perceptible at the boiler. Priming is thus reduced, and a general advantage in the steam-generating end of the plant is obtained.

The best method of wire-drawing is assumed to be that of placing the reducing valve within the steam space of the boiler, so that any heat produced by the conversion of energy may be reabsorbed in the surrounding steam; some form of nozzle, like that of an injector, is suggested as likely to give the best results.

"It seems that with water-tube boilers, the higher the pressure the better they work, and, this being so, all the advantage that can be had from wire-drawing ought to be taken. We have no hesitation in saying that in practice, with modern high pressures, more can be gained by judicious wire-drawing than by pushing expansion to a limit which is anything but judicious."

Technical Education and Foreign Competition.

ONE of the results of the pressure which foreign competition has produced in England is an awakening to a realization of the methods of work in competing countries; this includes not only the immediate mechanical methods of production, but also the influence which a higher technical education exerts upon the progress of industrial development. It is no doubt true that the division between the educated technologist and the operative workman is more sharply defined in England than in some of her competing neighbors.

This fact is fully appreciated in England, as many articles in the technical press of Great Britain show, and it was made the subject of the address of Sir William Bailey at the presentation of prizes at the Hindley Technical Schools, printed in *The Engineer* (October 22).

Sir William does not mince matters, but starts out boldly by showing the futility of self-deception in so important a matter. "Those who know anything of the work done in other countries--those who have studied the progress and skill in the first principles of the arts of industry and in the scientific use of force by our competitors abroad—know very much that should discount our pride and make us feel anxious about our commercial future prosperity. Until recently, technical education has been much ignored, if not entirely neglected, in this country. If, since the days of Elizabeth, half as much of the goodness and public piety and thought and work that has been given to the care of the poor and in the distribution of parish doles had been devoted to the prevention of ignorance, these monuments of woe and past neglect which are often the largest buildings in our towns, the workhouses, would have long since ceased to exist."

Proceeding, Sir William shows that systematic scientific investigation must take the place of mere hap-hazard inventing, so-called, and the methods of the scientific inventor, trained in full knowledge of what has been done in the past, as well as the laws which govern what may be done in future, must be applied in daily work, if industrial pre-eminence is to be maintained. The manufacturing industries of England owe their existence almost entirely to the inventive skill and natural ability of a body of practical men whose work extends barely one hundred years back; and it is an interesting fact that before the year 1733, when Kay invented the fly-shuttle, the methods of spinning and weaving in England were not superior to those used by the natives of the Pacific islands or the savages of Central Africa. Further advances now, however, must be made, not by men possessing merely practical experience and great imagination.

"The inventors of the present day must be scholars and educated men. Sir Henry Bessemer is a scholar, Sir Lowthian Bell is a scholar, and the late Dr. Joule was a scholar and high-class mathematician; and the trained scholars on the continent who have the management of the iron and steel industries serionsly affect the management of similar works in this country; and, unless we are more on the alert, some of our industries will be annihilated. Our mechanical appliances and improved processes, invented by Englishmen in the middle of the last century, caused us to be superior to our trade rivals abroad, and we must not be astonished when we are told that in America, and in Germany, and in France, many improved methods are being discovered which in some cases are superior to ours. The factory system that has been so successful in textile manufactures is being introduced into the production of machinery, and the hand-lathe and the common drilling-machine will shortly be ancient tools only fit for the machinery smith. It is for our manufacturers and captains of industry carefully to study the new movement, in order that we may retain and strengthen those manufactures which are being assailed."

This address is but one of many similar appeals, written and spoken, which are being made in England to endeavor to counteract the growing forces of foreign competition. Whether the awakening has come soon enough, time alone can tell; but of the reality of the danger there is little doubt, and the efforts to combat it will surely be made with energy and ability.

Railroad Building in South Africa.

DURING the past year railroad construction has been actively pushed in South Africa, and from an account in *Engineering* (October 22) some idea of the character and extent of the recent work may be gathered.

"A year ago Buluwayo was 587 miles distant by road from Mafeking, the most northern terminus then on the Cape railways; at the close of the present year the locomotive will enter that place which three years ago was but a kraal of the Matabele." This means that an average of 1¼ miles of railway have been constructed for every working day, and that this has been accomplished through a new country, with water and wood both scarce, and all supplies necessarily furnished from the rear. One can better realize what this piece of railroading means by taking the map of South Africa and tracing the course of the road as already built to Mafeking, and then carrying it on in nearly a straight line to Buluwayo.

The road will undoubtedly be an important factor in the future development of Rhodesia, and the strengthening of the British power in South Africa. The cost of traffic from Mafeking to Buluwayo by wagon was more than £100 per ton, and this will be reduced to £5 by rail. Especially is the road expected to prove of value for transportation of grain and breadstuffs, enabling men at the mines to be fed cheaply, and enormously facilitating the development of the country in every way.

The road to Buluwayo forms a portion of the system of Cape railways, and is intended to serve Matabeleland, the country to the north-east. Another branch is to be constructed, and is already partially under way, connecting Buluwayo to the port of Beira on the east coast of Africa a little below the mouth of the Zambesi. Beira is considered one of the best ports of South Africa, the tide having a mean rise of seventeen feet, the highest on the whole coast. A narrow-gage line is already being completed from Beira to the frontier of Mashonaland, and at Umtali, the frontier town, a new line is to be constructed to Fort Salisbury.

This work involves no extraordinary engineering difficulties other than those due to the tropical climate, the dense jungle, and the scarcity, in some places, of water. On the Buluwayo line steel sleepers are necessary, as wooden crossties are quickly destroyed by the white ants. The rails are sixty pounds in weight, and the bridges over the numerous rivers are of the Cape Standard type of girders, one hundred feet being the longest span.

The rapid completion of these roads in the very heart of South Africa must accelerate the development of Rhodesia to a marked degree, and the manner in which the Transvaal is thus being hemmed in by British power is worthy of consideration. Although the railways are undoubtedly built for commercial purposes in the first place, yet the strategic importance can hardly be considered as secondary. With double railway communication with excellent ports both on the south and the east coasts, forces and supplies could be thrown against the Transvaal from the front and the rear, while the absence of any sea communication, except through Portuguese territory, prevents any corresponding railroad connections from being built by the Boer government. The growth of British influence and power has everywhere been marked by railway construction, and South Africa is no exception to this rule. The development may be expected to proceed at an accelerating rate, and the outcome must soon be reduced to a question of endurance.

Electricity on the London Underground.

For some time the question of the substitution of electricity for steam as motive power on the London Underground Railways has been discussed, and in an editorial in *The Electrical Review* (October 15) some account of the present status of affairs is given.

The smoke and gas which render the underground travel so disagreeable can only partially be removed by fans and ventilating devices, and even these remedies have not been generally applied; and it is evident that the proper method of relief lies in a change of motive power. This is officially affirmed in the report of a special board of commissioners, in which it is most emphatically stated that the use of electric traction upon these roads will alone give a radically permanent improvement.

There are financial reasons which must be met before such a change can be undertaken, but, apart from these, the writer of the editorial assumes that there are "some very heavy technical difficulties to surmount before an efficient electric service can be set going." He then adds, however, that "engineers are in a much better position for giving satisfaction at the present time than they were a year or two since."

The technical difficulties referred to appear to be almost entirely included in the application of electricity to the present system of train service, and the system of signalling now in use would hardly permit any material increase in carrying capacity, if electric motors were merely substituted for steam locomotives. Then there are a number of trains belonging to the Great Western and North Western railways which are run on some parts of the Inner Circle, and it is hardly practicable to run the steam and the electric trains on the same roadway to advantage. In fact, there would be little use in putting in electric service at all on this portion of the underground, if steam locomotives also were permitted, since the smoke and gases from a few engines would be sufficient to foul the air.

The true remedy lies in the entire use of electricity, and in the complete abandonment of the locomotive-drawn train, substituting the independent motor cars which form one of the chief advantages of the electric system. An almost continuous flow of cars could then be kept up, and

London receive something she has not known since the underground was started, —*i.e.*, ample transportation facilities combined with absolute freedom from smoke and gas.

The *Electrical Review* adds: "In conclusion, it may be said that several years of steady working have shown the absolute success of electric traction upon the Liverpool overhead railway—a line where the service resembles in almost every particular that of the Inner Circle, except that the latter is, of course, considerably heavier, and has some amount of through traffic from other lines outside. We cannot think that the mere incident of one line being essentially in tunnel and the other in the open should make it impossible to operate the former successfully by the same methods that have done so well on the latter."

The Colombo Harbor Works.

THE port of Colombo, in Ceylon, is one which has constantly advanced with the growing trade of Southern India, and the expansion of Australia and New Zealand, and, from being an open roadstead, swept by the monsoons, it has been gradually improved, until, when the present and contemplated works are completed, it will be one of the finest harbors in the world.

An account of the improvements at Colombo, with hydrographic chart and plan, is given in *Indian Engineering* (September 4), containing many points of engineering interest.

The great monsoons which damage the shipping at Colombo come from the southwest; hence the first attempt to improve the harbor was the construction of a protecting breakwater on this quarter. This breakwater, which was one of the first to be constructed of concrete blocks made from Portland cement, is composed of a mound of rubble, brought up to twenty-four feet under low water, surmounted by concrete blocks weighing thirty-five tons each, set on edge, the plans being those of the late Sir John Coode, well known to engineers in all parts of the world for his experience in harbor works. The work constructed in 1875, has served its purpose well, withstanding the heavy storms and protecting the harbor from one side.

The new works, commenced in 1894, provide protection from the north and northwest, enclosing the entire space available for harbor construction, giving more than 600 acres of shelter area,—that is, exceeding the first-class Imperial Harbor of Refuge at Dover. These works, the cost of which is estimated at $4,550,000 are to be completed in eight years from, the date of the commencement, and are already completed to an extent which adds much to the harbor protection.

The enclosure of the harbor also renders possible the construction of a graving dock, which has been greatly needed.

At the present time all vessels are obliged to go from Ceylon to Bombay not only for the repair of serious injury, but also for the scraping and cleaning of the hulls, so frequently necessary in the Indian ocean. The coaling station is also to be greatly enlarged, thus making Colombo an important naval station.

The above estimate does not include the graving dock, this being a separate item of about $1,500,000, one-half of which is to be borne by the home authorities.

In connection with the account of these harbor improvements, it is interesting to note that the mercantile shipping frequenting the harbor of Colombo has increased from 700,000 tons in 1881 to 2,800,000 tons at the present time, besides the increase in naval requirements; so that the wisdom of expending the above-mentioned sums is fully established.

The Ventilation of Mines.

THE question of the proper ventilation of mines, and especially of collieries, has always been one of the important problems of mining engineering. Originally performed by the draft produced by furnace heat, this method has gradually been superseded by fan ventilation, until it has been for some time supposed that the use of fans, at least in large collieries, was the only proper method.

In a recent issue of the *Colliery Guardian* (October 8) Mr. H. W. Halbaum revives the idea of furnace draft for mine ventilation, and advances some strong points in its favor, quoting especially the work of a ventilating furnace at a large modern colliery in the north of England, and claims that, in some instances, it may be a decidedly better policy to ventilate a mine by means of a furnace than to ventilate it by means of a fan, even where a large volume of air is required.

This is true only in some instances, and it is to investigate those instances that the paper referred to was prepared. The real fact is that there are usually auxiliary aids to mine ventilation, which may be made of greater or less assistance, according to the method adopted for producing the main current of air. Where there are underground boilers and engines, the heat emitted may be so directed as to assist the upward current, and this may be made a useful auxiliary. In some cases, as Mr. Halbaum shows by a fully-computed example, an apparent furnace efficiency of more than 200 per cent. was demonstrated, based on the fuel consumed and the volume of air discharged. The impossibility of the truth of this, notwithstanding the correctness of the computation, led to the discovery that the mine air, which passed through the grate and fire-bed, contained enough combustible gases to add very materially to the quantity of heat generated, and to this and other sources of heat in the mine the excess work was due.

The fact that the mine air was combustible did not necessarily imply that there was danger of explosion, since it is quite possible for such proportion of gas to be present as to be capable of burning when in contact with incandescent fuel, and yet be entirely incapable of explosion, or even combustion, when taken apart from the furnace fire. Neither combustion or explosion can be propagated through the mass of so weak a mixture. This is well known in the case of a very "poor" producer gas; it will ignite and furnish a hot flame when a torch is held in its current, but the flame will instantly go out when the torch is removed, and the gas cannot be made to explode.

Mr. Halbaum also showed that, even when the assistance of this auxiliary fuel is not available, there are conditions under which the furnace, considered as a machine for moving air by the combustion of fuel, may be nearly, if not quite, as efficient as the more complicated mechanism of boiler, engine, and fan. Summing up, he concludes:

"First, there may be circumstances in which a furnace, viewed from the commercial-standpoint as a mine ventilator, may be more than able to hold its own with any type of ventilating fan.

"Second, a mine current containing an imperceptible percentage of fire-damp, or other combustible gases, is charged with an immense store of potential energy, which, under certain conditions, may be harnessed in the service of man."

THE CONTINENTAL PRESS

The Improvements at the Mouth of the Loire.

THE harbor of St. Nazaire, at the mouth of the Loire, has been an important seaport for many years. The regular mail steamship lines for the Antilles and for Mexico make it their port, much miscellaneous commerce uses the harbor, and many vessels pass up the river to the city of Nantes. Of late years there has been a perceptible shallowing of the channel, which formerly sounded a depth of twenty-two feet over the bar, and it has been found necessary to carry out extensive improvements in order to maintain freedom of access to the harbor. The works are fully described in the official record of the engineer, M. de Joly, in the *Annales des Ponts et Chaussées* (Part I, 1897), and the account is a valuable contribution to hydrographic work and harbor improvement.

The channel at the mouth of the Loire, although there was a well-defined bar, did not appear to shift or become shallower until comparatively recent years; but in 1871, much to the surprise of the residents, the steamer Florida, drawing twenty-two feet, found it very difficult to get over the bar, and the frequent recurrence of such detentions revealed the fact that the channel was filling up.

Hydrographic surveys showed that not only was the bar increasing, but that it had also shifted its location. By 1881, the depth of water in the channel had diminished to about twelve feet, and it was evident that, unless something was soon done, the port of St. Nazaire would be doomed.

The report of a government commission appointed to investigate the matter, recommended dredging, but this was opposed by M. Bouquet de la Grye, on the ground that the bar was composed of fine sand, which, under the influence of the currents and the prevailing winds would fill up the new channel almost immediately, rendering the work useless. The discussion led to a thorough investigation of the causes of the formation of the bar, with a view of so directing the improvement works as to render the results as permanent as possible.

The result of these investigations, including a combination of the influences of tides, currents, and prevailing winds, pointed to the conclusion that the best location for a permanent channel would be at another point in the bar than that hitherto used, and that the Saint-Marc channel, formerly the main channel, should be replaced by a deepening of the *traverse des Charpentiers*—so-called from certain rocks in the harbor.

After some experimental work this plan was adopted, and four powerful suction-dredges were set to work removing the sand from the line of the new channel, the contract providing for the removal of 1,000,000 cubic meters of sand (about 1,308,000 cubic yards) at a price of 80 centimes per cubic meter (12¼ cents per cubic yard), in twenty-six months.

As a matter of fact, the million cubic meters were removed in fourteen months, and a channel having a minimum depth of 6 meters (nearly 20 feet) and a width of 100 meters has been made through the Charpentier bar. One suction-dredge is maintained in service to guard against initial filling of the new channel, but there is every evidence that the care which was given to the selection of the location will make the maintenance of the channel an easy task.

The change in the position of the harbor entrance involved a rearrangement of the harbor lights and the construction of two new lighthouses, and, with the completion of this important detail, not only the port of St. Nazaire, but also the valuable river traffic of the city of Nantes, will be preserved and developed.

The Stockholm Exposition.

INTERNATIONAL expositions, as a rule, have a sameness about them which renders it difficult to select really salient points for description, but the recent exposition at Stockholm was distinctive enough to be worthy of special notice. Various accounts have appeared in the continental press, among which, for a general review, we may refer to that in *La Revue Technique* (September 25).

The original idea of the exposition, which was projected in 1894, was to furnish a demonstration of the recent progress of the Scandinavian peninsula only, but the inclusion of Russia practically resulted in the production of an exhibition of the arts and industries of the entire north of Europe, Denmark included.

Instead of borrowing the designs of other countries and periods, the architects, Messrs. Boberg and Lilljeqvist, produced buildings distinctively Scandinavian and local in design and coloring, with the result of impressing upon spectators the northern character of the exposition and its Scandinavian and Slavonian nature.

Norway and Sweden naturally made valuable exhibits in metallurgical products, especially in iron and steel, the forges of Motala and Bergsund being well represented, both in exhibits and in constructive details of the buildings. The fine carpentry and woodwork of Sweden was in ample evidence, and the great Palace of Industry, the main building of the exposition, is claimed to have been the largest wooden building ever made, covering an area of more than 160,000 square feet, and rising to a height of 310 feet at the top of the cupola.

The electrical exhibit was especially notable from the fact that the dynamos, of 200 h. p. each, were driven by de Laval steam turbines, actuated by steam at one thousand atmospheres' pressure, generated in special boilers, also designed by M. de Laval.

Historical and ethnological exhibits found place, an entire history of Swedish mining being made in the mining pavilion, while a great ethnographic museum, under the skilful direction of M. Hildebrand, the royal antiquary, was arranged in the open park within the grounds, including reproductions of portions of old Stockholm, and other historical subjects, furnishing both instruction and entertainment.

It is a question whether local expositions of this nature are not of more real value than the great aggregations of commercialism from all parts of the world known as "international expositions"; and it is more than probable that the great shows of the coming century will be thus differentiated either by subject or locality, to the real benefit both of exhibitors and visitors.

Chinese Mining Communities.

THE advancement of the works of the Trans-Siberian Railway into the Chinese gold fields of Manchuria is bringing to light much curious information about the Chinese methods of gold-mining, as well as the peculiar social institutions of the mines, and their relations to the empire. From an interesting article by M. de Batz in *Le Génie Civil* (September 25) we make some extracts.

The Chinese miners live in independent communities, having their own local government, under rulers of their own choosing. The most characteristic of these communities is that at the placers of *Tsia-pi-goou*, which has been in existence for a long time; thirty years ago, when this locality was visited by the archimandrite Palladius, the organization numbered ten thousand miners. The community is under the authority of a single leader, called the *da-è*, with whom two subordinate governors are associated. The gold obtained belongs to the entire community, being divided by the leader, with reservation of a portion for the needs of the non-productive workers and for the care of the sick. The *da-è* possesses arbitrary power for the judgment of disputes, and the administration of justice, even to the infliction of the death penalty; and the entire community is under his absolute rule. The Chinese government appears to have abandoned any attempt to exert authority over the miners, and, instead, has tacitly acknowledged the community by accepting from it a sort of resident representative with the governor of the province, through whom dealings are made with the imperial authorities.

Any attempt at independent mining in this district under such conditions is not to be considered, but it does not appear that new-comers are repulsed, if they are willing to do their share of the work and accept the community system of sharing the product.

Another powerful organization, which flourished until recently, was that known as the free community of miners of the Jeltouga. This body was first discovered in 1860, existing in a secluded valley in the Khingan mountains, where the placers were worked secretly, many of the miners being Russian exiles who had escaped from Siberia. The discovery of very rich gold deposits in this portion of the Amoor Valley in 1883 brought the district into notice, and many gold-seekers flocked thither, so that by 1885 the population of the valley reached nearly 15,000.

The influx of turbulent characters tried the stability of the primitive organization severely, but the formation of a sort of vigilance committee kept the disorderly elements under control until a strong arbitrary government was formed by a majority of the population, upon a community basis. The miners were divided into parties called *artels*, composed of nine men each, working on assigned and limited territory, and turning their output into the common fund. No miner was admitted into an *artel* without the consent of the others, and any one unable to work was obliged to furnish a substitute. The gold-bearing gravel was excavated from pits and washed in a primitive manner, and the richness of the deposits may be inferred from the fact that the average result of the washings of each *artel* of nine men, in a party of eight hundred working on a placer along the Arakane, was a little more than one kilogram of gold per day (a value of about $660).

Trouble, however, arose between the Russian and Chinese authorities in regard to the community, the Russian government forbidding its subjects to cross the Amoor into Chinese territory, the camp having become a refuge for escaped Siberian exiles. For a time the armed strength of the community was too great for the Chinese government, but, after several attempts, the independent government of the miners was broken up, and the rich placers are now worked by a Chinese stock company operating under a government concession, and organized by Li-Hung-Chang.

There seems to be little doubt that the Siberian railway will be the means of opening up valuable gold fields hitherto unworked, or worked only in a very imperfect manner, and that the immediate effect will be the suppression of much of the free mining, and of many of the mining communities.

Old Paper.

FROM time to time we hear various prognostications as to the ephemeral character of all modern printed and written works, owing to the bad quality of modern paper, and computations have been given of the extreme limit of duration of books and documents.

Fading inks on decaying paper are supposed to doom all modern literature to a short life, and the strong and durable paper of the " good old times " is held up as a reproof to the makers of the modern flimsy article.

A very interesting article in the second part of the *Mitt. aus den Kg. technischen Versuchsanstalten*, or transactions of the government testing laboratory, by Herr W. Herzberg, goes to show that, like many other stories of the good old times, the paper of past days was often not so good as that now made, and that, indeed, most of it was pretty poor stuff.

The author of the article goes into the history of paper-making in Europe, from the time of its introduction into Spain by the Moors in the eleventh century down to comparatively recent times, and shows that from its earliest use paper was thought fit only for passing documents, and that, when it was first used in bound books, it was thought necessary to bind alternate leaves of parchment and paper, as the latter was considered too brittle to stand the strain. Public documents were forbidden to be engrossed on so fragile a material as the earlier paper was found to be, and it was only as the art advanced that the new material superseded parchment.

A careful inspection of several hundred old codices in the Royal Library at Berlin fails to reveal any lasting properties of the old paper upon which they were written. On the contrary, the leaves are in very many instances crumbling into brittle fragments, while the writing has become illegible.

The durability of paper has been supposed by many to depend upon the material of which it is made, and the adoption of other substances than rags has been the origin of the alarm as to the poor quality of modern paper. As a matter of fact, the method of manufacture has so much to do with the strength and quality that the material is only one of several elements to be taken into consideration. Doubtless there is much poor paper made to-day, but there is also better paper made than any which existed in the "good old times," while almost any book now printed may be expected to show greater powers of endurance than those made on the best paper of preceding centuries.

Paris Sewer Construction.

In the course of the improvements in the sewerage of Paris, it was decided, in 1894, to construct a new main collecting sewer from the place de la Trinité to the siphon which passes under the Seine at Clichy. The large size of the proposed sewer, known as the *Collecteur de Clichy*, and the fact that the route passed under important and much-travelled streets, filled with shade trees and carrying tramways, caused the authorities to hesitate about cutting a trench for the conduct of the work. It was therefore decided to adopt a system of tunnelling, with such arrangement of shields and supports as would maintain the surface of the roadway intact, and permit the entire work to be carried on below ground, although the top of the sewer arch at places would come within three feet of the surface.

An account of the method and apparatus employed is given in the *Annales des Ponts et Chaussées* (Part I, 1897), showing very clearly how this important and difficult work was accomplished, and demonstrating how possible it is to avoid the upheaval of city streets for such constructions.

The sewer is of oval section, 20 feet wide and 16½ feet high inside, with arched walls averaging 21 inches thick, there being a central channel along the bottom, 13 feet wide by 6½ feet deep, for the flow of sewage, with narrow footways on each side, much the same as in the other main sewers of Paris. The total length of sewer is 3,970 yards, which was divided into two contracts, the first, including that portion without the fortifications, 1,610 yards long, and near the surface of the soil, and the second, 2,360 yards long, within the city limits.

In order to support the soil and the load upon the superincumbent roadway, it was necessary to adopt a metallic shield similar to that devised by Brunel for the construction of the Thames tunnel, and this shield was followed by a system of moveable centers, or frames, upon which the masonry was constructed and supported. As there was no liquid mass to be encountered, the end of the shield was left open, the structure really forming an elliptical ring of plate-iron with sharp edges, reinforced with angles and braces, and carrying six hydraulic cylinders, by means of which it could be forced forwards. The rams of these cylinders thrust back against the masonry ring previously constructed, through the medium of the metallic centerings already mentioned, while a horizontal bucket-conveyor kept the space just back of the shield free from earth as rapidly as the excavation progressed.

The general conduct of the work was simple, and will readily be understood with a knowledge of this apparatus. The hydraulic jacks had a stroke of one meter, and, as the earth was excavated in front, the shield was steadily forced forward, until the limit of stroke had been reached.

The pistons were then drawn in, and a metal center erected behind them, and the work of filling in the masonry followed closely behind the shield. A length of about fifty feet behind the shield was kept supported and braced by metallic centers, beyond which the masonry had become sufficiently solid to need no further support. A light platform, carried along the middle of the tunnel, supported a small track by which the masons were supplied with material, while the excavated earth or other similar material was hauled away below. Thus the work went on continuously.

The interior of the tunnel was kept well lighted by electricity, and all motive power for ventilating, hauling, pumping, etc., was supplied by electricity. The details were slightly different in the two portions of the work, owing to the different depths at which the tunneling was conducted, but the general construction was practically the same.

By the use of this apparatus, a sewer of 20 feet by 16 feet was thus successfully built for a distance of more than two miles under one of the busiest portions of Paris, the work progressing continuously at the rate of about six lineal yards in twenty-four hours, without causing the slightest obstruction to travel and without deranging the surface-paving. The contract price was about $200 per lineal yard, including the construction of all the apparatus.

Recent German Bridges.

WE have noticed at various times in these columns some of the important new bridges planned and under construction in various portions of Germany, and there is little doubt that this activity in bridge-building has contributed not a little to the present stimulus in the German iron and steel industries.

The principal bridges now being constructed in Germany are illustrated and compared in an article by Prof. Foerster, of the Dresden Technical High-School, published in *Stahl und Eisen* (September 15), from which we can gather some interesting facts.

The most noteworthy feature about these modern bridges is the practically universal use of the long span braced arch. Where a viaduct is to be carried over a deep valley, as at Müngsten, sufficient rise is afforded for an overhead bridge without difficulty, and a wide span arch is readily designed without overstepping economical proportions. Excellent precedents exist for this form of construction in the examples of the Garabit viaduct in the Pyrenees, and in the Luiz I. viaduct over the Douro at Oporto; and the Müngsten viaduct nearly approaches the latter in dimensions, being 492 feet clear span, with a total length of 1,525 feet, and a height above the river Wupper of 350 feet.

Like the Garabit viaduct, the great arch at Müngsten has been constructed without supporting false-works, the two halves of the span being carried out to meet each other, cantilever fashion.

Of the four new bridges now being built over the Rhine, two—those at Bonn and Düsseldorf—are designed with long-span arches, and, as these are low-level bridges, the necessary rise is obtained by carrying the arches far above the roadway and suspending the latter from them.

At Bonn two smaller arches of about 350 feet span extend from the banks to the piers from which the main arch of 640 feet springs, the roadway passing above the side arches and between the high braced arches of the main span.

The bridge at Düsseldorf has already been discussed at length in a previous review, and its two great arches of 594 feet span are practically identical in design and proportion with that of the bridge at Bonn.

Two bridges are under construction at Worms, one for general road traffic and the other a railroad bridge, each consisting of three arches of nearly equal span. The road bridge is of deck construction, the roadway passing entirely above the arches, and the lighter service permitting the flatter and shallower arches without unduly increasing the stresses, while the railroad bridge resembles in general design those at Bonn and at Düsseldorf, with the modifications in proportion due to the reduced span—about 330 feet.

The cost of these four Rhine bridges and the Müngsten viaduct is estimated at more than $4,000,000,—a very respectable sum to be expended in a limited time in one line of work,—and the completion of these notable structures will materially advance Germany as a possessor of fine bridges.

Portable Bulkheads for Mines.

ONE of the greatest obstacles encountered in combating fire-damp, or smoke, or noxious gases in mines lies in the difficulty of constructing bulkheads in the gangways leading to the dangerous portion of the mine and excluding the gases from the remainder of the workings while relief work is going on. A timber bulk-head, to be gas-tight, must be carefully constructed, and cannot be rapidly made, and workmen have frequently been overcome or driven back by the gas or smoke which they were endeavoring to exclude. In such work, time is the important element, and a few minutes may make all the difference between success or failure in so vital a piece of emergency service as the closing of a passage-way through which suffocating gases are pouring.

A recent scheme for meeting this difficulty has been devised by Herr Wagner, the superintendent of Prince Hohenlohe's mines at Michalowitz, in Silesia, and is fully illustrated and described in *Glaser's Annalen* (October 1). The device consists of a so-called portable " dam " similar in construction to an air mattress, which, when inflated with air, swells to an extent sufficient to close so tightly the gangway in which it is placed that no gas or smoke can pass.

The dam is composed of strong cotton fabric vulcanized with Para rubber and further rendered air-tight by a second layer of balloon-fabric. The front and back surfaces of the dam are connected at intervals within by straps about twelve inches long, so that, when fully inflated, the whole assumes the form of an elastic air mattress about twelve feet square by one foot thick, and, if placed on edge in a gangway of slightly smaller dimensions, the dam will effectually close the entire area. One side of the dam is provided with a suitable valve, gage, and hose connection ; and a small portable hand-pump enables the inflation to be rapidly accomplished.

The whole apparatus, when deflated, is very portable, and can be carried like a stretcher upon the light rods which are used to support it during inflation. Inflatable air bags have frequently been used to close off sections of large gas mains at points where no valves were available, and the use of such a device in a channel of regular outline readily suggests itself ; but we believe Herr Wagner is the first to extend the use of such obstructions to large and irregular passages, such as mine gangways and his apparatus has been found successful in practice in Germany in cases of gas and coal-dust explosions.

The Eckmühl Lighthouse.

THE already famous lighthouse system of France has recently been enriched by the completion of the fine " Eckmühl " lighthouse situated on the point of Penmarc'h on the Breton coast, in the department of Finistèrre. Full details are given in *Le Génie Civil* (October 9). This lighthouse owes its existence to the bequest of 300,000 francs, left for the purpose by the will of the late marquise de Blocqueville, the daughter of Marshal Davoust, prince of Eckmühl, historically famous as one of the ablest generals in the service of the great Napoleon. As the name indicates, it is intended not only to warn mariners from the dangerous coast of Brittany, but also to serve as a monument to the memory of the marshal of the empire, whose line has now become extinct.

The structure is a fine octagonal tower of granite, 207 feet high, with additional buildings for the reception of machinery and for the residence of the attendants. This height is sufficient to enable the tower to be seen for a distance of more than twelve miles on a clear day, while at night the powerful light penetrates more than sixty miles in clear weather, and, even in the misty atmosphere so frequently encountered on this coast, it can be seen for twenty-five miles.

The light used in the new tower is an improved form of flashing electric light, similar to that which has already been used in the Hève lighthouse, but much more powerful, photometric measurements placing its intensity at 30,000,000 candle power. The particular method of flashing called the "lightning-flash" has been devised by M. Bourdelles, the director of the French lighthouse service, and consists of a continuous series of flashes following each other as closely as practicable without longer duration than is necessary to permit a perception of the separate intervals. This has been found to be accomplished best by making the duration of the flashes about one-tenth of a second, the result being an effect similar to that of lightning. In investigating this system, care has been taken to determine the duration necessary for the flash to impress its maximum brilliancy upon the human eye, as any shorter period would result in an apparent diminution in the power of the light. Careful laboratory experiments by M. Charpentier have shown that the full intensity of a white light is appreciated by the eye between one-eighth and one-twelfth of a second, and hence for the French lighthouse service one-tenth of a second has been chosen.

The lighting apparatus is double throughout, two Serrin lamps with Fresnel lenses and prisms being arranged so as to be used either singly or together; the whole system is supported on a vertical shaft, the weight being balanced by a hollow iron float in a vessel of mercury, thus relieving the pivot from the pressure, and limiting the function of the vertical shaft to that of guiding and centering the moving parts.

Two independent steam engines of twelve horse-power each operate the alternating electric generators of the Labour type, and an air-compressor furnishes a blast for the operation of a powerful siren for use during fog. In order that the siren may be ready for immediate service in case of sudden fogs, a supply of air compressed to thirty pounds per square inch is maintained in a reservoir.

The completion of the Eckmühl lighthouse brings the number of electrically-illuminated lighthouses on the French coast to thirteen, this being many more than are in use by any other nation; indeed, it is generally admitted that no coast is so well provided with powerful and effective lights as that of France.

The Caissons of the Alexander III Bridge.

THE work upon the new bridge across the Seine at Paris, which is to form so conspicuous a feature of the coming exposition is being pushed steadily forward, and in *Le Génie Civil* (September 11) is given a fully illustrated account of the immense caissons upon which the piers will rest. The horizontal thrust of the arch will be very great, because of the extreme flatness of the curve, and this, together with the extreme width of the bridge (130 feet), causes the dimensions of the piers to be unusually great. The caissons measure 145 by 109 feet, by 12 feet deep, being second only in size to those for the towers of the Brooklyn suspension bridge, although the latter is more than five times the span of the Paris bridge.

The foundations within the caissons will be of Portland cement concrete, the caissons being sunk by means of the compressed-air system, each caisson being divided into five compartments having separate air shafts.

The walls are made of iron six millimeters thick, very thoroughly braced within, the lower edges, both of the outside sheets and of the inner partitions being shaped so as to penetrate the soil readily, as the structure sinks. A horizontal division extends over the whole area of each caisson, a little more than six feet from the bottom, and it is only below this portion that the pneumatic work is conducted, the masonry of the pier being built above.

Apart from the size of the foundations and the importance of the structure, there is no especial feature of note in this work. The location is comparatively free from difficulties, a sufficiently hard bottom being readily found at twenty-five to thirty feet below the surface of the Seine; and the experience which has so recently been acquired in the construction of the Pont Mirabeau furnishes excellent precedent for the present work, especially as the same contractors have it in charge.

Owing to the great area of these foundations, the pressure per unit of area has been kept within reasonable limits. Including dead weight and the vertical component of the arch thrust it is computed to be less than 2 kilograms per square centimeter (28.44 pounds per square inch).

The excellent progress which has been made upon the foundation work on both sides of the river gives assurance that the bridge will be completed within the required time, and that this important and conspicuous feature of the exposition will be entirely ready before the opening day.

Mechanical Recording Apparatus.

THE experiments of Professor Marey in animal locomotion, and the ingenious forms of apparatus which he devised for the purpose of investigating and recording animal movements, made his name well known in that connection many years before the application of instantaneous photography by Muybridge and his successors. An interesting article upon the general subject of mechanical recording devices by Professor Marey, in *La Génie Moderne* (September 15), possesses, therefore, especial value from the long and varied experience of the author in this line of investigation.

Many of the recent improvements in such apparatus are the direct results of the general advances in the art of photography. The production of exceedingly rapid emulsions, and the use of long celluloid films as supports, have alone rendered possible such devices as the kinetoscope and cinematograph,—instruments which, apart from their popular use as apparatus for entertainment, give unparalleled opportunity for the study of animal motion. Any special movement may be projected upon the screen in such a manner as to enable every phase to be examined in detail, at so moderate a rate of speed as to avoid any uncertainty or confusion. Compound movements may be investigated and dissected, and the entire subject revealed in a manner not otherwise possible.

In like manner the phonograph has been applied to special investigations of sound, including the study of "timbre," or the analysis of the various vibrations present in any sound of mixed character. This has been accomplished by Hermann, of Königsberg, by means of an ingenious auxiliary apparatus, which converts the indentations upon the cylinder of the phonograph into their corresponding curves, and these, by a subsequent harmonic analysis, may be separated into their various simple elements.

A still more recent application of chrono-photography is the attempt of MM. Roux and Balthazard to apply the Röntgen rays to continuous photography; and already some measure of success has been gained in photographing the internal organs in successive phases of motion, and thus investigating the mechanics of their action. The continued application of mechanical recording apparatus to the study of kinematic problems, whether in animate or inanimate subjects, cannot fail to add much to our knowledge in many directions, since we not only fix a permanent record of passing phenomena, but also eliminate one of the most confusing elements in all such work—the personal errors of individual observers. The work of many investigators may thus be preserved and compared, and an average result obtained, which will be nearer the truth than the work of any individual could be.

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American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila., Pa.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Journal. *m.* London
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila, Pa.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m.* New York.
Chautauquan. *m.* Meadville, Pa.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Contemporary Review. *m.* London
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York
Electrical Engineering. *m.* Chicago, Ill
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Elektrotechniker. *b-m.* Vienna.
Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.

Engineer. *w.* London.
Engineer. *s-m.* New York.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, Tenn.
Engineering and Mining Journal. *w.* New York
Engineering Magazine. *m.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester. *bi-m.* May's Landing, N.J.
Fortnightly Review. *m.* London.
Forum. *m.* New York.
Foundry. *m.* Detroit, Mich.
Garden and Forest. *w.* New York.
Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glasers Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades' Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash , D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q* New London, Conn.
Journal Political Economy. *q.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Journal of the Society of Arts. *w.* London.
Journal Western Soc. of Eng. *b-m* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kan.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London
McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal
Mining Industry and Review. *w.* Denver, Col.
Mining Journal. *w.* London.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. Stuttgart.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Science Review. *qr.* New York.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oesterr. Monatsschr. für den Oeff. Baudienst. *m.* Vienna.
Oesterr. Zeitschrift für Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *q.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revue Technique. *b-m.* Paris.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerisches Bauzeitung. *w.* Zurich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Scientific Machinist. *s-m.* Cleveland, Ohio,
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J.
Stone. *m.* Chicago, Ill.
Street Railway Journal. *m.* New York
Street Railway Review. *m.* Chicago, Ill
Technology Quarterly. Boston, Mass.
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill
Western Railway Club, Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Zeitschrift für Lokomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschrift des Oesterr. Ing. und Arch. Ver. *w.* Vienna.
Zeitschrift des Ver. Deutscher Ingenieure. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.
Zeitschrift für Instrumentenkunde. *m.* Berlin.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Court Buildings.

Court Buildings and Prison at Leipa, Bohemia. (Gerichtsgebäude und Gefangenhaus in Böhm-Leipa.) General description, with elevation and plans of these important civil buildings. 5000 w. 5 plates. Oesterr Monatschr f d Oeffent Baudienst—Oct., 1897. No. 16-194 D.

Edinburgh.

A Building Problem in Edinburgh. Extracts from report of Mr. M'Crae. The completion of the North Bridge makes it necessary to decide what shall be done with the sites for building along the new approach. The writer advocates the completion of the improvement, by the Council. 2700 w. Arch, Lond—Oct. 1, 1897. No. 15930 A.

Elevator.

Grain Elevator and Warehouse at Copenhagen. (Silo- und Bodenspeicher der Freihafen-Gesellschaft in Kopenhagen.) Description of this important structure with elevation and section. 1200 w. Oesterr Monatschr f d Oeffent Baudienst—Oct., 1897. No. 16-198 D.

Fireproof Construction.

The Best Fireproof Construction for Buildings Occupied for Mercantile Purposes. W. L. B. Jenney. Abstract of paper presented to the Fire Underwriters' Assn., giving suggestions that, if followed, would permit but little injury to the building other than smoking the walls and ceilings and blistering the paint. 5700 w. Eng Rec—Oct. 9, 1897. No. 15900.

Hotel.

The Astoria Hotel, New York City. Illustrated description of the Waldorf-Astoria hotel, as the completed structure will be called. 3000 w. Sci Am—Oct. 30, 1897. No. 16175.

Portable Buildings.

The Docker Pavilions. (Les Pavillons Docker.) Several forms of portable houses are illustrated and described, those shown being especially adapted for hospitals, and for temporary purposes in hot climates. Serial. Part I. 2500 w. La Revue Technique—Oct. 10, 1897. No. 16178 D.

Principles.

General Principles of Construction. Part first deals with materials and stability. 1300 w. Nat Build—Sept., 1897. Serial. 1st part. No. 15784 C.

Problems.

Some Important Problems in Construction. William W. Crehore. Discussing what should not be done; with reasons. Part first treats of the respective merits of cast iron and of built-steel columns in skeleton fire-proof construction. Ill. 1800 w. Br Build—Oct., 1897. No. 16-144 C.

School.

The New Buildings for the Royal Technical High School at Aix-la-Chapelle. (Der Neubau an der Königlichen Technischer Hochschule zu Aachen.) Elevation and plans of new buildings for the departments of mining and electrotechnics; costing $120,000. 1200 w. 1 plate. Glückauf—Sept. 18, 1897. No. 15854 B.

Tall Buildings.

The American Tall Building from a European Point of View. S. Henbest Capper. From an artistic standpoint the tall building is condemned when considered merely as a striving for "tallness." For a flat city like New York the sky line is improved. Lavish decoration is deemed inappropriate. Illustrations of notable European buildings are given for comparison. 3500 w. Engineering Magazine—Nov., 1897. No. 15-591 B.

University Buildings.

A Western City of Learning. Samuel E. Moffett. Explains the scheme of the University of California, aiming to secure the most artistic collection of buildings possible for the beautiful site at Berkeley, Cal. 4000 w. Harper's Wk—Sept. 11, 1897. No. 15027.

HEATING AND VENTILATION.

Penitentiary.

Heating and Ventilation of the Tennessee State-Penitentiary. Illustrated detailed description of plant furnished by the American Blower Co. 1000 w. Eng Rec—Oct. 9, 1897. No. 15901.

Radiation.

Heat Imparted from Surfaces with Various Temperature Differences. Leicester Allen. Reply to a correspondent desiring to know the number of British thermal units given off per square foot of direct-radiating surface per hour in a hot-water system and by steam radiation, under stated conditions, with information on the computation of heating effect. 1200 w. Heat & Ven—Oct. 15, 1897. No. 16073.

Railway Station.

Method of Heating Buildings where Three or More Stoves are Now Used. Report of committee as to best substitute for stoves in warming railway stations. 2500 w. Am Assn of Ry Supts of Bridges and Buildings. No. 15943 D.

Railway Ventilation.

See Railroad Affairs, Miscellany.

Senate Chamber.

Ventilating the United States Senate Chamber. A full description of the changes made to remedy the defects of the system installed. Ill. 3500 w. Eng Rec—Oct. 16, 1897. Serial. 1st part. No. 16058.

St. Louis Coliseum.

Heating and Ventilation of the St. Louis, Missouri, Coliseum. Illustrated description of the plant installed in a very large building. 1200 w. Heat & Ven—Oct. 15, 1897. No. 16072.

LANDSCAPE GARDENING.

Conifers.

Notes on Cultivated Conifers. C. S. S. Results of observations on cultivated conifers in the northern and eastern United States, including the Yew family. 1800 w. Gar & For—Oct. 6, 1897. Serial. 1st part. No. 15758.

English Gardening.

Penshurst Place. Brief description of the park and garden of this beautiful place in Kent. 1100 w. Gar & For—Oct. 6, 1897. No. 15757.

PLUMBING AND GASFITTING.

Factory Plumbing.

Plumbing in a New York Factory. Part first gives a general description, with requirements and arrangements of pipe lines and branches, roof tanks, cold water distribution and basement drainage pumping. Ill. 1300 w. Eng Rec—Oct. 2, 1897. Serial. 1st part. No. 15742.

Fatigued Metal.

Fatigued Metal. Edwin S. Marsh. Explains the cause of weakening of metals, which is one of the defects of house-plumbing. 800 w. Dom Engng—Oct , 1897. No. 16042 C.

Flushing.

A New Flushing System for Water Closets. Illustrated description of a system dispensing with the overhead tank, and substitutes the pressure of air in a vertical pipe about 3 ins. in diameter, its upper end closed. 800 w. Eng News—Oct. 21, 1897. No. 16084.

Report.

Plumbing Affairs at Washington, D. C. Annual report of the superintendent of the district plumbing service. 1400 w. San Plumb—Oct. 1, 1897. No. 15749.

Ventilation.

How Electricity May be Utilized to Advantage for the Local Ventilation of Plumbing Fixtures. James L. Lawler. Illustrated description, showing that the electric heater is the most practical, safest and best method of producing local ventilation. 1500 w. Dom Engng—Oct., 1897. No. 16041 C.

MISCELLANY.

Address.

President's Address before the Liverpool Architectural Society. W. E. Willink. Consists largely of a review of matters of interest since the formation in 1848. 5000 w. Builder —Oct. 9, 1897. No. 16060 A.

Belgium.

Review of the Architecture in Belgium. (Revue de l'Architecture en Belgique.) Charles Buls. Interesting illustrated description showing the influences that have affected the buildings in different localities. 2000 w. Jour of Roy Inst of Brit Arch—Sept. 23, 1897. No. 16107 D.

Byzantine Architecture.

Byzantine, or Early Christian Architecture. Cyrus K. Porter. Gives a brief general outline of the history of Byzantium, the early introduction of christianity and the customs of the time; the development of the architecture, and the countries influenced by it. 5500 w. Stone—Oct., 1897. No. 16103 C.

Churches.

The Country Church in America. William B. Bigelow. Churches of the United States, dating from 1630, are described and illustrated, and many interesting suggestions of church architecture are given. 5000 w. Scribner's Mag—Nov., 1897. No. 16114 C.

Competitions.

The Legal Status of the Pennsylvania Capitol Competition. Text of the opinion of Judge Simonton, sustaining the demurrer of four of the five State Capitol Commissioners, and dissolving the temporary injunction in the equity proceedings. 5000 w. Eng Rec—Oct. 23, 1897. No. 16129.

Draughtsmen.

Professional Draughtsmen as Special Students in the School of Architecture. William R. Ware. Explains why this class of students are admitted and the advantages and disadvantages to those most interested. 2700 w. Sch of Mines Quar—July, 1897. No. 16162 D.

Elevator.

A Traveling Staircase. (Un Escalier qui Marche.) Illustrated description of an inclined traveling way for general public use in the Magasins du Louvre at Paris. 1000 w. Le Génie Moderne—Sept. 15, 1897. No. 15833 B.

Exposition.

Review of the Works of the Exposition of 1900. (Exposition de 1900, Revue des Travaux) Describing and illustrating the demolition of the old Palais de l'Industrie and the construction of the foundations of the new buildings in the Champs Elysées. 2000 w. Le Génie Civil—Aug. 14, 1897. No. 15808 D.

The New Work in the Munich Crystal Palace. (Die Neuen Einbauten in den Münchener Glaspalast.) Showing the elaborate interior improvements and decorations made in connection with the international art exhibition at Munich. 4500 w. 2 plates. Oesterr Monatschr f d Oeffent Baudienst—Sept., 1897. No. 15850 D.

The Stockholm Exposition. (L'Exposition de Stockholm.) General description, with photographs of buildings and grounds. 1500 w. La Revue Technique—Sept. 25, 1897. No. 15585 D.

Fire Damage.

Behavior of Non-Fireproof Steel Building Construction in the Detroit, Mich., Fire. Frank M. Dunlap. Showing the excellent resistance made by the steel structure and describing the effect upon various kinds of construction, with photograph. 700 w. Eng News—Oct. 14, 1897. No. 15976.

Fireproofing.

Fireproofing Under Fireproofing Laws. Calls attention to the weak points that are allowed by architects, and advocates the use of terra-cotta as a protection of iron and steel frames. 2000 w. Br Build—Oct., 1897. No. 16145 C.

Floors.

Uniform Safe Loads for Building Floors. F. E. Kidder. Read before the convention of the International Assn. of Building Inspectors, at Detroit, Mich. Gives the writer's opinions and gives a summary of what he believes combines absolute safety with proper allowance for economy. 2200 w. Arch & Build—Oct. 16, 1897. No. 16018.

German Architecture.

Ecclesiologia Germanica. T. Francis Bumpus. Impressions obtained during a short tour among the old cities and towns of Westphalian-Prussia and Thuringian-Saxony. Ill. 2800 w. Arch, Lond—Oct. 8, 1897. Serial. 1st part. No. 16024 A.

Historic Churches.

Some Historic Churches of America. Thomas Morgan Prentice. Historical review, with illustrations, of many noted churches, with interesting references to their architecture. 6000 w. Harper's Wk—Oct. 23, 1897. No. 16077.

Illinois Legislature.

Architecture a "Close" Profession in Illinois. A bill for an act to provide for the licensing of architects and regulating the practice of architecture as a profession. 3000 w. Eng News—Oct. 21, 1897. No. 16090.

Kitchens.

The Kitchen. Editorial article on good arrangement and fittings. 1000 w. Nat Build—Sept., 1897. No. 15785 C.

Mausoleum.

The Grant Mausoleum, New York. Editorial discussion of mausoleums in general, with criticism of the architecture of the tomb named. 2500 w. Builder—Sept. 25, 1897. No. 15713 A.

Monument.

The William I Monument at the Porta Westphalica. Description with illustration, and account of the changes made from the original plan. 900 w. Sci Am—Oct. 9, 1897. No. 15767.

Mortars.

The Use of Wet Sand in the Making of Mortars. P. Hervieu. Translated from *Nouvelles Annales de la Construction.* Retards the setting by inducing the formation of aluminate of lime, and affects the volume. Results of experiments. 800 w. Br Build—Oct., 1897. No. 16146 C.

Renaissance.

Renaissance Architecture. T. Roger Smith. Opening lecture of the Architectural Classes delivered at University College, London. Explains what is meant by "Renaissance," describes typical buildings, and gives an outline of this extensive subject. 5700 w. Arch, Lond—Oct. 8, 1897. No. 16023 A.

Sheffield.

The Architecture of Our Large Provincial Towns. Sheffield, England. Interesting illustrated description of the place and its architecture. 6000 w. Builder—Oct. 9, 1897. No. 16059 A.

Tall Buildings.

The Modern Tall Building. Owen Brainard. Reasons for this class of architecture, its development, design, and novel features. Ill. 3000 w. Chau—Nov., 1897. No. 16224 C.

Training.

The Educational Training of Architects.—A Rejoinder. Leopold Eidlitz. A reply to the discussion of a paper read before the Royal Institute March 1, 1897, answering the criticisms advanced by different speakers. 6000 w. Jour Roy Inst of Brit Arch—Sept. 23, 1897. No. 16108 D.

Wall Decoration.

Gesso Work and "Fillings." Walter J. Pearce. Illustrated description of this class of work. 1800 w. Plumb & Dec—Oct. 1, 1897. No. 16025 A.

CIVIL ENGINEERING.

BRIDGES.

Arches.

Calculation of the Thrust of Arches. (Note sur le Calcul de la Poussée des Voûtes.) M. Tourtay. Giving simple formulas and a table of coefficients by means of which the thrust can be determined for segmental arches of known loading. 3000 w. Ann des Ponts et Chaussées—Part II, 1897. No. 15877 F + G.

The Influence of an Inclined Load Line upon a Symmetrical Arch (Einfluss Geneigter Nivelletten auf Symmetrische Gewölbe.) An elaborate analytical investigation, showing the magnitude and direction of stresses for a given loading. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—October 8, 1897. No. 16192 B.

Beam.

Investigation of the Maximum Efforts Developed in a Horizontal Beam of Single Span by the Passage of a Train. (La Recherche des Efforts Maxima Développés en un Point dans une Poutre Horizontale à une Travée par le Passage d'un Train.) An analytical investigation by M. G. Rogie. 5500 w. Ann des Ponts et Chaussées—Part II, 1897. No. 15876 F + G.

Design.

The Esthetics of Bridge Design as Exemplified by Two Recent New York Bridges. Alfred P. Boller. An interesting article on this subject, with views of the Central Bridge and Harlem Ship-Canal Bridge at Kingsbridge Road, New York. 2400 w. Eng News—Oct. 7, 1897. No. 15771.

Drawbridge.

Plate-Girder Swing Bridge at Ottawa, Illinois. Illustrated description of a bridge on the C. B. & Q. railroad, crossing the Illinois and Michigan canal, the special features of construction necessary to adapt it to its low position being of interest. 700 w. Ry Rev—Oct. 16, 1897. No. 16064.

Swing Bridges on the Chicago Drainage Canal. Specifications and conditions for some of the bridges for which bids are now invited. Diagrams are given showing the truss outlines, and a few typical maximum strains and sections. 800 w. Eng Rec—Oct. 2, 1897. No. 15741.

The Tower Bridge at London. (Le Pont de la Tour, à Londres.) A very good account of the Tower bridge over the Thames, discussed from a French point of view. With plate of details of the bascules and hydraulic machinery for operating them. 3500 w. 1 plate. Le Génie Civil—September 25, 1897. No. 16182 D.

Failure.

An Instructive Failure of a Highway-Bridge Abutment. W. L. Cowles. The failure of the Washington street bridge in Pottsville, Pa., is described and illustrated. 1000 w. Eng News—Oct 14, 1897. No. 15975.

Fall of a Bridge at Tarbes. Editorial criticism of the construction and the cause of the failure in France. 2300 w. Engr, Lond—Sept. 24, 1897. No. 15689 A.

The Failure of the Adour Bridge at Tarbes. (La Rupture du Pont sur l'Adour à Tarbes.) A very full account, with numerous illustrations, of the failure of the steel girder bridge at Tarbes, France, while undergoing test just after completion. 4500 w. Le Génie Civil—July 31, 1897. No. 15802 D.

Floors.

See Railroad Affairs. Maintenance of Way.

Foundations.

The Foundation Caissons for the Bridge Alexander III. (Caissons de Fondation du Pont Alexandre III.) Illustrated description of the construction and launching of the great caissons for the shore foundations of the new bridge over the Seine, at Paris. 5000 w. 1 plate. Le Génie Civil—September 11, 1897. No. 15814 D.

Framework.

Computations for Double-Hinged Arch Frames under Horizontal and Inclined Forces. (Berechnung des Zweigelenkbogens unter Einwirkung Wagerechter und Schräger Kräfte.) An analytical and graphical discussion of the action of framed structures with especial reference to wind stresses. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—October 1, 1897. No. 16191 B.

Germany.

Recent German Bridges. (Neuere Deutsche Brückenbauten.) With photographs of bridges now in course of erection and elevations of the large bridges and viaducts of recent design. A valuable article by Prof. Foerster of Dresden. 6000 w. Stahl und Eisen—September 15, 1897. No. 15846 D.

Niagara.

Bridges Across the Niagara. Brief account with illustrations. 500 w. St Ry Rev—Oct. 15, 1897. No. 15984 C.

Paris.

The Alexander III Bridge over the Seine at Paris. (Die Brücke Alexander III über die Seine in Paris.) A very full description from a special correspondent, with plates of details. 5000 w. 2 plates. Oesterr Monatschr f d Oeffent Baudienst—October, 1897. No. 16196 D.

Quebec.

Proposed Bridge Across the St. Lawrence River at Quebec. Information of site and plans for the construction of a railway bridge, with estimate of cost, general dimensions, and other particulars. 1200 w. Eng News—Oct. 14, 1897. No. 15977.

Replacing Bridge.

See Railroad Affairs, Maintenance of Way.

Rolling Bridge.

The Rolling Bridge at Cherbourg. (Le Pont Roulant de Cherbourg.) Describing and illustrating the new bridge at the Cherbourg docks. The bridge is drawn back by hydraulic power. 2000 w. Le Génie Moderne—October 1, 1897. No. 15836 B.

St. Lawrence Bridges.

Bridges over the St. Lawrence for the New York and Ottawa. Brief illustrated description of two bridges being constructed from Cornwall, Ont., to a point near Hogansburg, N. Y. The channel is divided by an island which is also crossed on an embankment about three-quarters of a mile long. 700 w. R R Gaz—Oct. 1, 1897. No. 15683.

Viaduct.

The J. F. Lépine Bridge over the Northern Railway of France. (Pont J. F. Lépine sur la Tranchée du Chemin de fer du Nord.) Describing the placing of the trusses of a street viaduct over a wide railway cutting in Paris. The completed bridge was pushed bodily over a span covering 10 tracks without interrupting travel. 5000 w. 1 plate. Le Génie Civil—September 4, 1897. No. 15812 D.

The Saint Bernard Bridge. (Le Pont Saint Bernard.) An illustrated account of the erection of a truss bridge at rue Lépine over a cutting of the Northern Railway of France at Paris. A pair of bowstring trusses were pushed over a cutting 132 feet wide without interrupting traffic beneath. 2500 w. La Revue Technique—October 10, 1897. No. 16176 D.

Victoria Bridge.

The New Victoria Highway Bridge, Brisbane, Australia. Photographs and description of a new six-span, highway bridge, with account of its construction. 1500 w. Eng News—Oct. 7, 1897. No. 15770.

CANALS, RIVERS AND HARBORS.

Caisson.

Movable Caisson for Repairing Dock Walls. (Caisson Mobile pour la Réparation des Murs de Quais.) Describing the appliances used for repairing the walls of the docks at Calais, under water. 3500 w. 1 plate. Ann des Ponts et Chaussées—Part I. 1897. No. 15872 F+G.

Channel.

Cutting a Channel through the Charpentier Bar. (Le Creusement d'un Chenal à travers la

Barre des Charpentiers.) M. de Joly. The official account of the works at the mouth of the Loire; with hydrographic charts, details of dredging machinery, &c. 17500 w. Two plates. Ann des Ponts et Chaussées—Pt. I, 1897. No. 15869 F+G.

Chicago Canal.

Progress of Work on the Chicago Drainage Canal. Table showing the amount of work done up to Sept. 1st, 1897, on each of the several contracts, and the amount of work remaining to be done. From report of Mr. Isham Randolph, chief engineer. 500 w. Eng News—Sept. 30, 1897. No. 15658.

Colombo.

The Colombo Harbor Works. History of the various improvements made, especially the recent work which has made this one of the finest artificial harbors in the world. Map. 2800 w. Ind Engng—Sept. 4, 1897. No. 15781 D.

Cranes.

The Electric Cranes at the Port of Havre. (Les Grues Electriques du Port du Havre.) Illustrated description of four radial electric cranes mounted on gantries on the Quai Colbert at Havre, with an account of the tests to which they were subjected. 3500 w. Le Génie Civil—September 18, 1897. No. 15818 D.

Dams.

Needle Dams. (Les Barrages à Aiguilles.) Describing the difficulties in operating the movable dams on the Meuse, and the improvements devised by M. Baudisson. 4500 w. 1 plate. Ann des Ponts et Chaussées—Part II. 1897. No. 15875 F+G.

Profiles for Masonry Dams. (Profils des Barrages en Maçonnerie.) M. Pelletreau. An analytical investigation of ordinary profiles and suggestions of a method of reinforcement giving greatly increased strength. 30000 w. 1 plate. Ann des Ponts et Chaussées—Pt I, 1897. No. 15868 F+G.

Gauging.

Gauging and Measuring the Flow of Water. (Wasseraichungen und Ueberfallmesssungen.) With illustration and description of the measuring tanks and weir used at the Kaiserbrunnen near Vienna; using the Bazin formula. 3000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—September 17, 1897. No. 15830 B.

Haulage.

Experiments of the Danube Navigation Company. (Expériences faites par la Société de Navigation sur le Danube.) An account of the dynamometric tests of the resistance of boats to haulage under various loads and speeds. 2000 w. Le Génie Civil—July 31, 1897. No. 15803 D.

See also Electrical Engineering, Power.

Lighthouse.

The Construction of the Raz-Tina Lighthouse. (La Construction du Phare de Raz-Tina.) M. Regnoul. Description with plate of details of this important new work at the port of Sfax in Tunis. 4000 w. 1 plate. Ann des Ponts et Chaussées—Pt. I, 1897. No. 15870 F+G.

The "Eckmühl" Lighthouse. (Le Phare d'Eckmühl.) A description of the fine new lighthouse erected on the Point de Penmarc'h, France, with plate of details of lighting apparatus, and pneumatic siren. 7500 w. 1 plate. Le Génie Civil—October 9, 1897 No. 16185 D.

Lock Gates.

Details of Gates for the Cascades Canal Lock. Drawings showing the details of construction of these great gates. 100 w. Eng News—Oct. 28, 1897. No. 16211.

The Gates of the Cascades Canal Lock, Columbia River, Oregon. Interesting account of the canal built to overcome obstructions in this river, with special illustrated description of the lock and guard-gates. 2500 w. Eng News—Oct. 21, 1897. No. 16087.

Locks.

Machinery for Operating Locks of the St. Mary's Falls Ship-Canal. Illustrated description of the mechanism for opening and closing the gates and for controlling the culverts in this noted canal of the United States. 1100 w. Marine Engng—Oct., 1897. No. 15911 C.

Nicaragua.

The Clayton-Bulwer Treaty. Mayo W. Hazeltine. This treaty, which declared that a canal crossing the Nicaragua isthmus should remain forever under the joint control of the United States and Great Britain, is discussed, with actions bearing upon it, and whether it has been rendered voidable. 3000 w. N Am Rev—Oct., 1897. No. 15724 D.

Paris.

Paris a Seaport. (Paris Port de Mer.) A revival of the scheme for a ship canal between Rouen and Paris. 1500 w. La Revue Technique—Sept. 25, 1897. No. 15586 D.

Shears.

Shears of 80 Tons Capacity at the Port of Bordeaux. (Bigue de 80 Tonnes du Port de Bordeaux.) Detailed description with plate of illustration; the inclination and hoisting are effected by direct-acting hydraulic cylinders, with an auxiliary tackle for light loads. 1500 w. 1 plate. La Revue Technique—Sept. 25, 1897. No. 15584 D.

Spree.

The River Spree at Berlin. (Die Spree in Berlin.) Official account of the river improvements and canalization in Berlin and vicinity. 7500 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—September, 1897. No. 15849 D.

Ship Canal.

The Proposed Florida Ship Canal. Information of the proposed construction of this canal, with the arguments in its favor. 1700 w. Bd of Trade Jour—Oct., 1897. No. 16220 A.

Tide Gauge.

A Registering Tide- and Rain-Gauge. (Ueber einen Registrirenden Pegel und Regenmesser.) A column of water is sustained by atmospheric pressure and the variations of pressure due to varying levels operates the registering pencil. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—October 8, 1897. No. 16193 B.

Towage.

The Cable Towage of Boats. (Le Halage Funiculaire des Bateaux.) Describing the cable system devised by M. Maurice Lévy for towing the boats through the Mont-de-Billy tunnel on the canal between the rivers Aisne and Marne. 7500 w. 1 plate. Ann des Ponts et Chaussées—Part II, 1897. No. 15874 F+G.

Weirs.

The Recent Investigations of Bazin on the Flow of Water over Weirs. (M. Bazin's Neuere Untersuchungen über den Abfluss an Ueberfallen.) A very full abstract of Bazin's most recent hydraulic experiments with tables, diagrams and formulas. 9000 w. Oesterr Monatschr f d Oeffent Baudienst—September, 1897. No. 15852 D.

Weser.

Improvement Works on the River Weser. (Wasserbauten an der Weser.). A. Herbst. A description, based upon a personal tour of inspection by the official engineer of the Austrian Department of the Interior, with plate of channel sections and topographical map. 4500 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—October, 1897. No. 16195 D.

Wharf Improvement.

Modern Wharf Improvements and Harbor Facilities. Foster Crowell. Devoted largely to American coal handling plants; also giving plans of docks at Antwerp, Hamburg, Dunkerque, Marseilles, and Glasgow. The defects of American harbors are compared with the superior arrangements of the European ports. 5000 w. Engineering Magazine—Nov., 1897. No. 15589 B.

IRRIGATION.

Dam.

The Construction of the Hemet Dam. James D. Schuyler. An account before the Technical Society of the Pacific Coast, of the construction of this high masonry dam in California. The water supply is used for irrigating over a thousand acres. Discussion follows. Ill. 7000 w. Jour Assn of Eng Soc—Sept., 1897. No. 15990 C.

Ogden, Utah.

See Electrical Engineering, Power.

MISCELLANY.

Address.

Presidential Address before the Architectural Association. Hampden W. Pratt. Reviews the fifty years work of the association. 6500 w. Arch, Lond—Oct. 15, 1897. No. 16155 A.

Beams.

The Ultimate Strength of Concrete-Steel Beams. J. B. Johnson. Abstracted from a paper read before the Detroit meeting of the American Assn. for the Advancement of Science. Gives assumptions and equations derived. 500 w. Eng News—Oct. 21, 1897. No. 16086.

Cement.

The Growing Importance of Cement in Constructive Work. Edward Wilkins Dewey. The reduced price of German Portland cement and the improvement in the American product is causing a great increase in use. Rosendale cement and English imported are being crowded out. The relation of domestic production to imports is tabulated and a great increase in consumption predicted. 4500 w. Engineering Magazine—Nov., 1897. No. 15594 B.

Clay.

Improved Furnace for Drying Clay, (Nouveaux Fours pour le Séchage de l'Argile.) Describing and illustrating the Toldt oven, in which the masses are turned as they descend inclined planes. 1500 w. 1 plate. Le Génie Civil—September 18, 1897. No. 15819 D.

Rock Drill.

The Siemens & Halske Electric Rock Drill. (Der Elektromotor—Schlagbohr maschine, System Siemens & Halske.) Describing especially the use of the drill in the Nassbach tunnel in Austria. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—September 3, 1897. No. 15827 B.

Wagon Roads.

A Steel Trackway for Wagon Roads. Illustrated description of experiments being made by the United States Department of Agriculture to determine the practicability of steel trackways. The object is to furnish a wear-resisting surface, reduce the expense of maintenance, and the labor of hauling heavy loads. 1600 w. Ir Age—Oct. 7, 1897. No. 15751.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

Coal Trade.

The Expansion of the American Coal Trade. Extracts from a pamphlet written by Joseph W. Burke, under the title of "A Great National Question," dealing with this subject, and showing the extent and value of the Great-Warrior coal-fields in Alabama, with comments. 1500 w. Mfrs Rec—Oct. 15, 1897. No. 16017.

Combination.

A Possible Bituminous-Coal Combination. Remarks on the results of the settlement of the soft-coal miners' strike in the United States, and the probability of an alliance to benefit the bituminous trade. 1100 w. Bradstreet's—Oct. 9, 1897. No. 15783.

Communities.

The Free Communities of Miners in Manchuria. (Les Communautés Libres de Mineurs en Mandchourie.) R. de Batz. An interesting account of the independent organizations among the gold miners of China, having local government, systems of working and sufficient strength to be practically free of the Imperial authority. 1800 w. Le Génie Civil—September 25th, 1897. No. 16184 D.

Competition.

American Competition. (La Concurrence Américaine.) A review of the development of the American iron trade from a French point of view, condensed from a study by M. Traseuster in the Revue Universelle des Mines. 2500 w. Le Génie Civil—September 18, 1897. No. 15820 D.

British Trade and Foreign Competition. Editorial on the information furnished by the publication of returns from the colonies, noting some of the causes of the displacement of British goods, and calling attention to some points of detail. 1400 w. Builder—Oct. 16, 1897. No. 16149 A.

Future Supremacy in the Iron Markets of the World. J. Stephen Jeans. The opening of the Lake Superior Region, the improvements in machinery and methods and especially the greater value of high priced labor, give the American iron industry controlling advantage in the competition with European manufacturers. 4800 w. Engineering Magazine—Nov. 1897. No. 15588 B.

The Utility of Competition. Calls attention to the fact that competition stimulates improvements, improves the quality and cheapens the cost of goods, gives larger wages and steadier employment. 1500 w. Clay Rec—Sept. 28, 1897. No. 15736.

Cost Keeping.

See same title under Mechanical Engineering, Shop & Foundry.

Education.

A Comparison of Courses in 17 German Technical Schools. (Vergleichende Zusammenstellung aus den Programmen von 17 Deutschen Technischen Fachschulen.) With an elaborate chart showing the proportion of time given to various studies, giving a full discussion of the subject from the German standpoint. 10000 w. Zeitschr ver Deutscher Ingenieure—September 11, 1897. No. 15822 D.

Export Duty.

The Proposed Export Duty on Canadian Ores. Suggestions from the standpoint of the interests of Canada. Considers that these duties, at this time, would be detrimental to Canada. 1500 w. Can Min Rev—Sept., 1897. No. 15717 C.

Exposition.

The Present Condition of Preliminaries for the Paris Exposition of 1900. (Ueber den Heutigen Stand der Vorarbeiten für die Weltausstellung in Paris 1900.) A discussion by Prof. Exner before the Austrian Society of Engineers of the best method of making an exhibit under the special classification adopted for this Exposition. 5000 w. Zeitcher d Oesterr Ing u Arch Ver—September 10, 1897. No. 15828 B.

Germany.

England's Opportunity in Germany. Comment on the sale of the North-German Lloyd fleet of seven steamers, which have been employed in the trade between the Weser ports and the United Kingdom, the effect on British shipping and on trade. 600 w. Trans—Sept. 24, 1897. No. 15709 A.

The Trade of Germany. Editorial on the danger of injuring British trade with continental and other countries, while striving to extend trade with the colonies and the far east. Calls attention to points in consular reports. 1300 w. Engng—Sept 24, 1897. No. 15686A.

Meat Shipment.

Preservation of Meat by Freezing Processes. (Conservation des Viándes par les Procédés Frigorifiques.) Report of M Deiss upon an inspection of British methods of shipping meat for long distances, with details of cost. 2500 w. Le Génie Civil—Sept. 11, 1897. No. 15817 D.

Museum.

A Commercial Museum. Information of the collection and arrangement of the world's production at the Philadelphia Commercial Museum, in its temporary quarters, and of the location and cost of the building being constructed to receive it. 3000 w. Harper's Wk—Oct. 9, 1897. No. 15715.

Regulations for the Commercial Samples Museum in Japan. From the *Japan Weekly Mail*. Information of the samples that may be exhibited, and rules affecting them. 700 w. Bd of Trd Jour—Oct., 1897. No. 16221 A.

Prices.

The Causes of the Fall in Prices Since 1872. Jeremiah W. Jenks. Address before the New York State Bankers' Assn. A consideration of earlier causes of changes in general prices, the arguments of writers on all sides, with conclusions from the study. 8000 w. Bankers' Mag, N Y—Oct., 1897. No. 15978 D.

South Africa.

The Commercial and Industrial Situation in the South African Republic in 1896. (Situation Commerciale et Industrielle de la République Sud-Africaine en 1896.) Abstract of a report of the French consul, with statistics and map. 2500 w. Le Génie Civil—Aug. 7, 1897. No. 15807 D.

Tariff.

Canada and the Dingley Bill. John Charlton. A brief outline of the character and capabilities of Canada is given, the desirability of close commercial relations between this country and the United States is discussed, the effect of the Dingley bill on the free list, and the advantage to both countries of intimate trade relations. 4000 w. N Am Rev—Oct., 1897. No. 15721 D.

New Cuban Tariff and British Trade. Memoranda respecting the changes which have been made by the new Cuban tariff in the duties on the principal articles which Cuba imports from Great Britain and British possessions. 1800 w. Bd of Trd Jour—Oct., 1897. No. 16222 A.

Tariff Changes and Customs Regulations. United Kingdom and France, Bulgaria, Russia, Norway, Germany, Algeria, Guiana, Ivory Coast, Spain, Switzerland, Costa Rica, Guatemala, United States of Colombia, Cyprus, British India, British Honduras, Dominica and Victoria. 6000 w. Bd of Trd Jour—Oct., 1897. No. 16223 A.

Trade Unionism.

The Effects of Trade Unionism upon Skilled Mechanics. Hiram S. Maxim. Trade unionism results in opposition to modern machinery and methods, dulls and retards the skilled mechanic and is detrimental to the country by curtailing the output and delivering the industries into the hands of competing nations of independent workmen. Many forcible illustrations from personal experience are given. 3500 w. Engineering Magazine—Nov., 1897. No. 15587 B.

Union Label.

Another View of the Union Label. Starr Hoyt Nichols. Briefly reviews the article of Miss M. E. J. Kelly, in a recent number of this publication, and presents quite opposite views. Holds that the label is a device to make the boycott more efficient. Examines the methods used by its promoters in the United States. 5000 w. N Am Rev—Oct., 1897. No. 15722 D.

Winter Load Line.

North Atlantic Freeboards. Editorial discussion of the trade complications growing out of the North Atlantic winter restrictions in loading of vessels. 1400 w. Engr, Lond—Sept. 24, 1897. No. 15688 A.

CURRENCY AND FINANCE.

Gold Standard.

The Austro-Hungarian Bank, and the Adoption of the Gold Standard in Austria. Charles A. Conant. The history of banking in this country and a study of the effects of a depreciated paper currency. 5500 w. Bankers' Mag, N Y—Oct., 1897. Serial. 1st part. No. 15979 D.

Indian Currency.

The Indian Currency Position. Hermann Schmidt. Discussing the new Indian monetary policy, and concluding that it is not settled thus far. 2000 w. Bankers' Mag, Lond—Oct., 1897. No. 16104 A.

Legislation.

What Legislation is Needed with Respect to the United States Currency. N. B. Van Slyke. Address at the annual convention of the American Bankers' Assn. An outline of the writer's views, and suggestions. 1500 w. Bankers' Mag, N Y—Oct., 1897. No. 15981 D.

Royal Mint.

The Report of the Royal Mint. Information of interest relating to the coinage of the British Empire, and comparing other countries. 2300 w. Bankers' Mag, Lond—Oct., 1897. No. 16105 A.

Silver Question.

India's Case for Silver. A. S. Ghosh. States the present condition of affairs in this country, resulting from the closing of the mints, and considers what would be the effect if silver were restored to its former value. 3500 w. N Am Rev—Oct., 1897. No. 15727 D.

Present Status of the Silver Question. Richard P. Bland. A paper advocating the free coinage of silver. 3000 w. N Am Rev—Oct., 1897. No. 15726 D.

GOVERNMENT CONTROL.

Corporations.

The Powers and Privileges of Corporations versus the Rights of the People. Austin W. Wright. Part first calls attention to the fact that all the powers of corporations were granted by the people themselves, through their chosen representatives, and suggests the course necessary to correct the mistakes made, discussing the subject generally. 4800 w. Elec Engng —Oct. 15, 1897. Serial, 1st part. No. 16054.

LABOR.

Eight-Hours Day.

The Eight-Hours Working Day. An endeavor to look at the position from both sides of view and to examine the facts of the case. 1800 w. Elec, Lond—Sept. 24, 1897. No. 15710 A.

Immigration.

Immigration and the Educational Test. Prescott F. Hall. Discussion of this question, showing how undesirable are the masses who come to the United States, and the effect upon labor, and the general good. Recommends a reading and writing test for admission. 4000 w. N Am Rev--Oct., 1897. No. 15719 D.

Legislation.

Democracy and the Laboring Man. F .J. Stimson. An outline of the legislation, concerning labor, existing in various parts of the United States, which has been enacted in the past ten years, discussing what can be accomplished by wise and proper legislation. 10000 w. Atlantic M—Nov., 1897. No. 16116 C.

Organization.

Free Labor versus Trade Unionism. States the object of the National Free Labor Association, which has recently held a successful meeting in London. 2000 w. Engr, Lond—Oct. 15, 1897. No. 16137 A.

Machinery.

Man and the Machine. Henry C. Potter. The writer explains the circumstances under which he made remarks which have been greatly misrepresented by the press, and gives his opinion of the effect on the worker of the employment of machinery in manufacture, urging the amelioration of the conditions. 3300 w. N Am Rev—Oct., 1897. No. 15718 D.

Strike.

The Strike and the Lock-out. The present condition of the strike in England, especially the importance of Birmingham, and the policy adopted there, with its bearing on engineering troubles. Also editorial. 6800 w. Engr, Lond—Oct. 15, 1897. No. 16139 A.

Tools.

See Mechanical Engineering, Miscellany.

MISCELLANY.

Capital.

Organized Capital: Its Privileges and Its Duties. Harvey J. Hollister. Paper presented at the annual meeting of the American Bankers' Assn. Considers the privileges and duties of the administrators of capital. 3800 w. Bankers' Mag, N Y—Oct., 1897. No. 15980 D.

Failures.

An Improving Record of Failures. A tabulated statement of business failures in the United States and Canada for nine months in two years, with assets and liabilities, and discussion. 1200 w. Bradstreet's—Oct. 2, 1897. No. 15674.

Millionaires.

What Millionaires Have Done. Lyman J. Gage. Extract from an address at Peoria, Ill. Showing the great benefits to society from the invested capital that they so often condemn. 1700 w. Bul of Am Ir & St Assn—Oct. 20, 1897. No. 16055.

Prosperity.

The Foundations of Our Growing Prosperity. Ossian D. Ashley. Outlines the causes of the depression in the United States, and the fundamental facts which constitute the basis of the revival in business. 4000 w. Ry Mag—Aug., 1897. No. 15677 C.

United States.

The Economic Situation in the United States. D. M. Frederiksen. Discusses the causes of the continuation of the hard times, the revival of business, the reform of the currency and various questions now before the American people. 3500 w. Bankers' Mag, Lond—Oct., 1897. No. 16106 A.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Electrolysis.

Determination of Nickel and Cobalt in Iron and Steel. (Dosage du Nickel et du Cobalt dans les Fontes et les Aciers.) Giving an account of the electrolytic method of M. Ducru for the rapid and accurate determination of nickel and cobalt, with tables of results. 1000 w. La Revue Technique—Oct. 10, 1897. No. 15599 D.

Furnace.

The Electric Furnace and the Work of M. H. Moissan. (Le Four Electrique et les Travaux de M. H. Moissan.) A general review of Moissan's recently published work, with illustrations and details of the results obtained by him. Three articles, 7000 w. Le Génie Civil—Aug. 21, 28, Sept. 4, 1897. No. 15811 H.

Nickel.

The Electrolytic Winning and Refining of Nickel. Report of experiments of Dr. F. Foerster, as published in the *Zeitschrift für Elektrochemie*, with account of other work in this field. 1600 w. Elect'n—Oct. 8, 1897. No. 16061 A.

LIGHTING.

Arcs.

Notes on the Electric Arc. Thomas Hesketh. Comments on the lack of attention given to developing the arc lamp, and gives a study of the factors influencing the efficiency of the direct current arc. 4000 w. Elect'n—Sept. 24, 1897. No. 15702 A.

Engines.

Steam Engines for Electric-Lighting Purposes. John Davidson. Paper read before the Salford Science Students' Assn., at Salford, England. Remarks on a few of the main features of high-speed steam engines, and the difficulties met with in satisfactorily designing them. Ill. 1400 w. Mech Wld—Oct. 15, 1897. Serial. 1st part. No. 16121 A.

Hammersmith.

Hammersmith. Illustrated description of an English electric-light station, with history of the undertaking. 4200 w. Elec Eng, Lond—Oct. 1, 1897. No. 15925 A.

Hartford.

The Hartford Electric-Light and Power Plant. Illustrated description of the plant of a city using more electric light and power than any other in the United States. 1600 w. Sci Am—Oct. 9, 1897. No. 15766.

Isolated Plant.

A Model Isolated Plant. Illustrated description of a modern and complete plant installed for H. N. Higinbotham, at his country home near Joliet, Ill. 2300 w. W Elect'n—Oct. 2, 1897. No. 15737.

Lamps.

Relative Value of 220-Volt and 110-Volt Lamps. Francis W. Wilcox. Discussion of when it will pay to install a 220-volt system. 2800 w. Elec Wld—Oct. 2, 1897. No. 15740.

Station.

Electric-Lighting Station at Garfield Park, Chicago. Illustrated detailed description. 1700 w. Power—Oct., 1897. No. 15732.

Steamship Lighting.

The Lighting of the Steamship Kaiser Wilhelm der Grosse. Illustrated description of the fine lighting equipment, and power appliances. Also the three powerful telephones. 700 w. Elec Wld—Oct. 2, 1897. No. 15739.

Street Lighting.

See Municipal Engineering, Miscellany.

Tennessee.

The Electrical Features of the Tennessee Centennial. Illustrated description of some of the beautiful effects in lighting, and of the plant and applications for power. 1700 w. Elec Wld—Oct. 9, 1897. No. 15796.

POWER.

Centralization.

The Centralization of Electricity Supply for Lighting, Power, Tramways and General Purposes. Arthur Wright. Considers the question of adopting some combined arrangement for supplying electricity for various purposes, from one center. Also editorial. 4800 w. Elec Rev, Lond—Sept. 24, 1897. No. 15707 A.

Central Station.

Central Electric Station of the Davis Coal and Coke Company. Timothy W. Sprague. Describes an extensive plant in West Virginia installed for a company mining and shipping bituminous coal and manufacturing coke. 2200 w. Min Ind & Rev—Sept. 30, 1897. No. 15714.

Converters.

Rotary Converters and Their Uses. Louis Bell. Gives an informal description of their properties and uses, showing that the rotary converter furnishes the most efficient and useful method of getting continuous from alternating currents. Discusses when and how it can be advantageously employed. 2500 w. Am Elect'n —Oct., 1897. No. 15788.

Cranes.

See Civil Engineering, Harbors. See also Marine Engineering.

Edison's Mine.

See Mining and Metallurgy, Iron and Steel.

Electrical Machinery.

Hints on the Care of Electrical Machinery. William Baxter, Jr. Difference between the two electric systems, the alternating and the continuous, and their relative merits. Ill. 3000 w. Power—Oct., 1897, No. 15733.

Haulage.

Electric Canal Haulage in France. From *l'Industrie Electrique.* Illustrated description of a system being installed in the Aire and Deule canal. 700 w. Elec Eng, N Y—Oct. 21, 1897. No. 16169.

See also Civil Engineering, Canals.

Insulation.

Insulators for Electric-Power Transmissions. T. A. W. Shock. Read before the Santa Cruz Convention of the Pacific Coast Electric Transmission Assn. Reports the experience with insulators on the lines of the Sacramento Electric, Gas and Railway Co. 900 w. Jour of Elec—Sept., 1897. No. 15903.

Insulators for Use on High Voltages. Henry D. Sears. Read before the Santa Cruz Convention of the Pacific Coast Electric-Transmission Assn. States the conditions to be fulfilled by a good insulator, and discusses the materials used, quoting extracts from standard authorities. 1600 w. Jour of Elec—Sept., 1897. No. 15905.

The Line Insulation of 16000 Volts. C. H. Van Norden. Read before the Santa Cruz Convention of the Pacific Coast Electric-Transmission Assn. A solution of the problem of insulation as attempted by the Central California Electric Co., with experience gained. 1000 w. Jour of Elec—Sept., 1897. No. 15902.

Line Construction.

The Construction of Transmission Lines. John S. Eastwood. Read before the Santa Cruz Convention of the Pacific Coast Electric-Transmission Assn. Discusses line location, materials, and construction. 2500 w. Jour of Elec—Sept., 1897. No. 15904.

Mine Transmission.

Latest Developments and the Practical Application of Alternating Multiphase Machinery for Electric Power Transmission. Walter Dixon. Paper read before the Federated Institution of Mining Engineers, discussing the applications to mining purposes. 2500 w. Ir & Coal Trds Rev—Oct. 1, 1897. No. 15931 A.

Montreal.

The Lachine Rapids-Montreal Electric-Power Transmission-System. Illustrated description of a large enterprise of great importance in the industrial developments of Canada. 1800 w. Elec Wld—Oct. 2, 1897. No. 15738,

Motive Power.

See Railroad Affairs, Transportation.

Niagara Falls.

The Extension of the Power Plant of the Niagara Falls Power Co. Orrin E. Dunlap. Description, with illustrations, of the extension of the power-house and wheel-pit, and other changes. 1100 w. Eng News—Oct. 14, 1897. No. 15967.

The Falls Harnessed. Historical account of the two power companies at the Falls of Niagara, with many illustrations. 5000 w. St Ry Rev—Oct. 15, 1897. No. 15985 C.

Ogden, Utah.

The Power Transmission Plant at Ogden. Illustrated description of an extensive plant laid out with the intention of supplying energy for light, power, and railway purposes, both in Ogden and Salt Lake City, Utah, and also for mining, and water for irrigation. 1600 w. Elec Wld—Oct. 16, 1897. No. 16048.

Printing.

Electric Power for Operating Printing and Binding Machinery. Reed R. Bishop. Abstract of a thesis presented to the faculty of Applied Science of Columbia University, New York City, for the degree of Electrical Engineer. Details in reference to the use of electric power for operating printing presses, cutters, folders, etc., including all machinery necessary for the production of a complete book. Ill. 1400 w. Elec Wld—Oct. 9, 1897. Serial. 1st part. No. 15798.

Switch Boards.

Three-Phase Switch-Boards, Apparatus and Synchronizing Methods. H. E. Raymond. Detailed description of a few cases which cover most of the ordinary requirements. 2000 w. Am Elect'n—Oct., 1897. No. 15787.

Transmission.

The Chambly Manufacturing Company's Electrical Power-Transmission Plant. Illustrated description of this fine installation, near Montreal, Canada. 1500 w. Elec Wld—Oct. 9, 1897. No. 15795.

The Electrical Power-Transmission Plant at Three Rivers, Quebec. H. R. Leyden. Illustrated description of the first long distance plant to be installed in Canada. 2200 w. Elec Wld—Oct. 9, 1897. No. 15797.

TELEGRAPHY AND TELEPHONY.

Cables.

A New Method of Localizing Total Breaks in

Submarine Cables. C. W. Schaefer. Interesting study of this problem, with description of the method the writer has found best. 5500 w. Elect'n, Lond—Oct. 15, 1897. No. 16143 A.

Cable Testing.

A Forgotten Method of Cable Testing. A. Tobler. Describes a method recalled by the perusal of a pamphlet published twenty-two years ago. The insulation resistance is tested by loss of charge. 900 w. Elec Rev, Lond—Oct. 8, 1897. No. 16051 A.

Calling Apparatus.

A Synchronous Calling-Apparatus for Telegraph Stations. Illustrates and describes an apparatus invented by H. Wetzer, by which each station may be called independently. 400 w. Elec Eng, Lond—Sept. 24, 1897. No. 15704 A.

Electric Lines.

Modern Construction and Maintenance of Electric Lines. William Brophy. Abstract of a paper read before the Mayor's Convention, Columbus, Ohio. Favors the underground construction, and discusses the overhead lines, fire and police telegraph-apparatus, &c. 1800 w. Elec Eng, N. Y.—Oct. 7, 1897. No. 15754.

Exchange.

The Construction and Working of a Typical Telephone Exchange. J. Wright. The object is to explain as simply and explicitly as possible the construction and mode of working of a small exchange on the English National Telephone Company's system as equipped at the present time. Ill. 2000 w. Elec Eng, Lond—Oct 1, 1897. Serial. 1st part. No. 15927 A.

History.

The Electric Telegraph. J. Warren. Historical account of the efforts to communicate by telegraph, dating from the sixteenth century. 2400 w. Elec, Lond—Oct. 15. 1897. Serial. 1st part. No. 16117 A.

Life Saving.

The Telephone in the Life-Saving Service. William Bolton. A letter from the superintendent of United States Telephone Lines Life-Saving Service, explaining the value of the instrument in the saving of life and property. 1400 w. Elec Rev, N. Y.—Oct. 6, 1897. No. 15763.

Patents.

Infringing Telephone Patents. G. S. Maxwell. Calling attention to the difficulty of securing the apparatus needed to equip telephone-exchange systems without infringing. 1000 w. Elec Engng—Oct. 1, 1897. No. 15786.

Telephone System.

The Smith-Vassar Telephone System. Illustrated description of a new system about to be offered to the public, claiming to afford economical service for local telephony. 800 w. Elec Rev, N. Y.—Oct. 6, 1897. No. 15762.

Wireless Telegraphy.

Telegraphy Without Wires. H. Melville Dowsett. Brief account of a demonstration of "telegraphy without wires," which took place in New Southgate, Eng., under the direction of Signor Marconi. Ill. 1200 w. Elec Eng, Lond—Oct. 1, 1897. No. 15928 A.

MISCELLANY.

Accumulators.

Notes on Accumulator Construction. Desmond G. FitzGerald. Considers how to find the number of plates that a given cell or vessel will contain; and how to find the dimensions of a cell or vessel to contain a given number of plates. 450 w. Elec Eng, Lond—Oct. 1, 1897. No. 15926 A.

Recent Progress in Accumulator Manufacture. (Neuere Fortschritte der Akkumulatorentechnik.) A review of recent progress in storage battery construction, including descriptions of the Pollak, Correns, Gülcher, Linde and Leitner batteries. 5000 w. Glaser's Annalen—Sept. 15, 1897. No. 16187 D.

Storage Batteries. E. J. Wade. From a forthcoming book to be published by *The Electrician* printing and publishing company. Part first discusses the nomenclature, the classification of electrodes, and the material of supports. 2500 w. Elect'n—Sept. 24, 1897. Serial. 1st part. No. 15703 A.

Armatures.

A "Surface-Plate" Balancing Rig. James F. Hobart. Some hints on the accurate mechanical balancing of armatures, with illustration of a testing apparatus. 1000 w. Elec Wld—Oct. 23, 1897. No. 16168.

The Magnetic Field in Tunnel Armatures. F. G. Baily. Discusses the problem of the relation of the mechanical and magnetic forces in conductors buried in a magnetic medium. 1800 w. Elect'n, Lond—Oct. 15, 1897. No. 16142 A.

Batteries.

Thermo-Electric Batteries. C. J. Reed. An explanation of the two general classes of thermo-electric batteries, with illustrated description of types. 1700 w. Elec, Lond—Oct. 15, 1897. Serial. 1st part. No. 16118 A.

Carbon.

Carbon for Electrical Purposes. Facts of interest about the carbon used in the arc lamp and for electrolytic work. 2000 w. Ir & Coal Trds Rev—Oct. 1, 1897. No. 15932 A.

Cells.

Standard Cells. W. C. Fisher. A defense of the Clark cell. 1700 w. Elect'n—Sept. 24, 1897. No. 15701 A.

Clocks.

An Electrical Time-Recording System. Describes a system possessing several features of novelty. A method of automatically operating a number of subsidiary clocks, which may be placed any distance apart from a master timepiece. Ill. 1000 w. Prac Eng—Oct. 8, 1897. No. 16067 A.

Currents.

Effect of Electric Currents on Adjacent Material. James B. Cook. Report of chairman of the special committee of the American Inst. of Architects, given at Detroit, Sept. 29, 1897. Gives theories and investigations made, offering suggestions. 3500 w. In Arch—Oct., 1897. No. 16109 D.

Cut-Outs.

Cut-Outs. Ed. C. de Segundo. Tabulated results from the researches of C. M. Clark and C. W. Macmullen of Columbia University, with comments. 900 w. Elec Rev, Lond—Oct. 1, 1897. No. 15922 A.

Distribution.

Conduits and Cables. Alex. Dow. Describes this practice of the present day with reasons for its adoption, and briefly reviews the earlier conditions. 6000 w. Jour Assn of Eng Soc—Sept., 1897. No. 15989 C.

Fuses.

An Accurate and Reliable Fuse. Louis W. Downes. Describes a method that has been found most successful in eliminating the causes of failure. 3000 w. Am Elect'n—Oct., 1897. No. 15791.

Circuit Breakers and Fuses. F. V. Henshaw. Criticises articles that have appeared on this subject, thinks both have a distinct value under different conditions, but that a fuse can be made to meet all conditions more nearly than a circuit breaker. 1100 w. Am Elect'n—Oct., 1897. No. 15790.

Kirchhoff's Laws.

Kirchhoff's Laws, and Network Calculations. Ellis H. Crapper. Considers, in an elementary manner, Kirchhoff's laws and the methods of applying them. 1300 w. Ind & Ir—Oct. 1, 1897. Serial. 1st part. No. 15933 A.

Lightning.

What We Have Learned About Lightning Since the Time of Franklin. John Trowbridge. Explains the views held by Franklin, and the progress made since, due largely to photography. 2000 w. Chau—Nov. 1897. No. 16225 C.

Microphonograph.

The Perfected Dussaud Microphonograph. (Le Microphonographe Dussaud Perfectionné.) The improved instrument records very feeble sounds, also enables deaf persons to hear clearly the sounds previously impressed upon the recording cylinders. 1200 w. Le Génie Moderne—September 1, 1897. No. 15831 B.

Mold Making.

Porcelain Mold Making. Jacob Henny. Describes a new art arising from the special requirements of the construction of electrical machinery, Ill. 1000 w. Am Mach—Oct. 28, 1897. No. 16201.

Muscular Electricity.

Muscular Electricity. J. Wright. A study of the electrical phenomena attendant on a simple muscular contraction. 1500 w. Elec Rev, Lond—Oct. 15, 1897. Serial. 1st part. No. 16124 A.

Resistances.

The Rating of Resistance Spirals. V. Zingler. Gives an improved method of rating spirals of wire. It no longer becomes necessary to take a certain section of wire for the current, and measure off the ohms required by a bridge. 2000 w. Elec Rev, Lond—Sept. 24, 1897. Serial. 1st part. No. 15705 A.

Rock Drill.

See Civil Engineering, Miscellany.

Self-Induction.

A Method of Measuring the Coefficient of Self-Induction of a Conductor. Lawford H. Fry. Describes a simple method, due to Herr Thiermann, of the Hanover Polytechnikum, which has been used with very good results in the laboratory. 350 w. Elec Rev, Lond—Sept. 24, 1897. No. 15706 A.

Spectra.

Arc Spectra. Arthur L. Foley. Investigations undertaken for the purpose of verifying the results of previous research and of so extending the work as to make it possible to arrive at some more definite conclusion. 7500 w. Phys Rev—Sept., 1897. No. 15794 D.

Testing.

Construction of an Electrical Testing Set. James F. Hobart. Part first gives description and engravings of a measuring instrument constructed by the writer. The making is described. 3000 w. Am Elect'n—Oct., 1897. Serial. 1st part. No. 15793.

MARINE ENGINEERING.

Battleship.

Launch of H. M. S. Canopus. Illustrated description, dimensions, special features and fittings, of one of a new class of battleships, designed by W. H. White. 1800 w. Engr, Lond—Oct. 15, 1897. No. 16136 A.

Beacons.

The United States Light-House Board's New Metal Beacons. Illustrated description of beacons intended for day marks and for survey stations. 1000 w. Eng News—Sept. 30, 1897. No. 15662.

Bulkheads.

Water-tight Bulkheads for Vessels. (Ueber die Wichtigkeit der Wasserdichten Schattwande auf den Schiffen.) An abstract of Middendorf's paper giving the theory and proper practice for the location of bulkheads in vessels. 7000 w. Oesterr Monatschr f d Oeffent Baudienst—September, 1897. No. 15851 D.

Coal Handling.

See Mechanical Engineering, Miscellany.

"Constitution."

The Frigate Constitution. Ira N. Hollis. Reviews the history of this vessel, which is considered to mark the beginning of the United States navy, giving many interesting events connected. 9000 w. Atlantic M—Nov., 1897. No. 16115 C.

The Hundredth Birthday of the Frigate "Constitution." J. D. Jerrold Kelley. Gives an interesting historical account of this famous

American ship. 2200 w. Harpers Wk—Oct. 23, 1897. No. 16078.

Cranes.

Electric Cranes on the Steamship "Bremen." (Schiffskrahne an Bord des Dampfers "Bremen.") An illustrated account of the electrical hoisting plant on one of the North German Lloyd steamers. 1200 w. Glaser's Annalen —September 15, 1897. No. 16189 D.

Diving Bell.

A Diving Bell for Deep Water Wrecking. Description, as given by J. S. Gadsden in the *Inter-Ocean*, of the form of diving bell being used in trying to recover a cargo of copper from the sunken steamer in Lake Huron, near Alpena, Mich. 1200 w. Eng News—Oct. 14, 1897. No. 15968.

Dry Dock.

A Floating Dry-Dock for Havana. Illustrated official description of the dock, with explanation of the essential characteristics of floating docks. 1700 w. Sci Am—Oct. 16, 1897. No. 15950.

Ferry.

The Ferry Steamer Chebucto. Illustrated description of a Canadian double-screw ferry steamer. 700 w. Engr, Lond—Oct. 8, 1897. No. 16029 A.

Fisheries.

Steam Power in the Fishing Business in Europe. Charles Theodore Mason. Information of steamboats used for this business in various countries. 800 w. Sci Am Sup—Oct. 16, 1897. No. 15959.

Gunboat.

Light-Draught Gunboat. Illustrated description of one of the gunboats built for the Egyptian Government. 1900 w. Engng—Oct. 8, 1897. No. 16037 A.

Japanese Navy.

The Coming Sea-Power. Charles H. Cramp. Traces briefly the development of the maritime power of Japan from its foundation, with special attention to her present naval activity, and speculations as to the purpose. 2700 w. N Am Rev—Oct., 1897. No. 15723 D.

Loading Coal.

See Railroad Affairs, Miscellany.

Lost Vessels.

What the Ocean Claims. Interesting data from Lloyd's Register for 1896, especially as related to the United Kingdom. 700 w. Trans —Oct. 8, 1897. No. 16071. A.

Marine Boilers.

See Mechanical Engineering, Boilers.

Merchant Vessels.

Our Need of Merchant Vessels. Alex R. Smith. Editorial Review of an article by Eugene Tyler Chamberlain, in the October Forum, on the United States Merchant Marine, with criticism. 2300 w. Sea—Oct. 7, 1897. No. 15782.

Paddle Steamer.

The Largest and Fastest Paddle Steamer in Great Britain. A. J. Sinclair. An exterior and interior view of the new steel paddle steamer "Empress Queen," with description. 1300 w. Sci Am—Oct. 23, 1897. No. 16080.

Record Breaker.

Transatlantic Record Breaker Kaiser Wilhelm der Grosse. Illustrated description of the fine North German Lloyd liner which recently broke the record of the route from Southampton to New York. 1800 w. Marine Engng—Oct., 1897. No. 15908 C.

Roller Boat.

The Roller Boat Problem. Editorial on the causes of failure in the Bazin boat, and the mistakes in design of the Knapp boat. 1200 w. Sci Am—Oct. 30, 1897. No. 16173.

Stability.

The Various Methods of Determining the Stability of Vessels. (Ueber verschiedene Methoden der Stabilitäts bestimmung von Schiffen.) A very thorough discussion of this important subject by Inspector Schromm, with tables, diagrams and stability curves. Three articles. 15000 w. Zeitschr d Oesterr Ing u Arch Ver—August 27, September 3 & 10, 1897. No. 15826 D.

Shafts.

Tail-end Shafts. Report on the causes of trouble, prepared at the special request of the British Committee of the Bureau Veritas by John Gravell. 1600 w. Mech Wld—Oct. 8, 1897. No. 16053 A.

Shipbuilding.

English and German Shipbuilding. (Englishcher und Deutscher Schiffbau.) A paper by Prof. Oswald Flamm, discussing the growth of British shipbuilding from a German standpoint. 6000 w. Stahl und Eisen—September 1, 1897. No. 15843 D.

Steamship.

Steel Lake-Steamship Starrucca, of Five Thousand Tons Displacement. Illustrated description of the vessel and the launching. 900 w. Marine Engng—Oct., 1897. No. 15910 C.

The "Kaiser Wilhelm der Grosse." Description, with engravings showing the interior decorations. 1600 w. Engng—Oct. 1, 1897. No. 15914 A.

The T. S. S. "Kaiser Friedrich." Brief description of a fine vessel, of the North German Lloyd, recently launched in Dantzig. 1100 w. Engng—Oct. 8, 1897. No. 16040 A.

Steamship Construction.

The Advancement in Steamship Construction. Editorial discussing whether the large proportions and great speed of the Atlantic liners will pay, and the importance of the ship-building industry, its advances and improvements. 2000 w. Am Ship—Oct. 14, 1897. No. 15957.

Steamship Lighting.

See also Electrical Engineering, Lighting.

Stern Wheeler.

Pittsburg and Cincinnati Packet-Line Stern-

Wheel Steamer Queen City. Bert L. Baldwin. A statement of the conditions and requirements of the river service in the Western United States, with illustrated description of the steamer named. 4300 w. Marine Engng—Oct., 1897. Serial. 1st part. No. 15909 C.

Torpedo Boats.

Torpedo Boats in Naval Warfare. Benjamin Micou. Gives the history of torpedo construction, describes their deadly action, calls attention to the small number of these boats owned by the United States, and recommends increasing the number. 3000 w. N Am Rev—Oct., 1897. No. 15720 D.

The Torpedo Boat. A review of the development of this class of war vessels. Considers the essentials to be speed and invisibility. 1400 w. Ir Age—Oct. 28, 1897. No. 16205.

Tugboats.

Dutch-Built Tugboats. Illustrated description of some of the powerful tugboats sailing under the Dutch flag. 4200 w. Steamship—Oct., 1897. No. 15929 A.

Twin Screw.

Twin-Screw Channel Steamer "Roebuck." Illustrated description of two new English channel steamers, giving longitudinal section, deck plans, and photograph of the Roebuck. 1100 w. Engng—Sept. 24, 1896. No. 15685 A.

Yachts.

Small Yachts and Yacht-Racing—1897. W. P. Stephens. New developments indicating a radical change in yachting for the immediate future. Ill. 1800 w. Harper's Wk—Oct. 9, 1897. No. 15716.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Calorimetry.

Determination of the Calorific Value of Coal with the Mahler Calorimeter and by Jüptner's Formula. (Die Bestimmung des Brennwerthes von Kohlen mittels des Mahler'schen Calorimeters und nach Jüptner's Empirischer Formel.) A review by Baron von Jüptner of the American tests of Messrs. Lord and Haas. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—August 14, 1897. No. 15856 B.

Coal Handling.

Coal and Ash Handling Apparatus. Descriptions with illustrations of the systems in general use. 2500 w. Am Elect'n—Oct., 1897. No. 15789.

Some New Lake Erie Coal-handling Plants. Illustrated description of some of the improved plants located at the beginning of the lake water routes. 1400 w. Eng News—Oct. 7, 1897. No. 15774.

Economy.

Importance of the Boiler. Showing that boilers do not receive the attention they deserve, that they are greatly affected by the surroundings with which each is erected, and that improvements after location often improve the economy. 1300 w. Bos Jour of Com—Oct. 2, 1897. No. 15748.

Efficiency.

The Efficiency of Tube Surface in Locomotive Boilers. (Die Wirksamkeit der Heizrohre in Lokomotiv Kesseln.) A theoretical discussion of this important subject, with valuable experimental data for tubes of various lengths under different conditions. 7500 w. Zeitsch d ver Deutscher Ingenieure—September 18, 1897. No. 15823 D.

Evaporation.

A Theoretical Study of Evaporation in Steam Boilers. (Etude Théorique de la Vaporisation dans les Chaudières.) H. Brillé. An analytical and graphical investigation by means of which the evaporation of a given boiler can be computed. Tables and curves are given showing a very close agreement between computed values and the results of actual tests. A valuable article. Three papers. 10000 w. Le Génie Civil—August 21, 28, September 4, 1897. No. 15810 H.

Explosions.

Boiler Explosions in the Year 1896. (Die Dampfkessel-Explosionen während des Jahres 1896.) Tabulating the explosions which occurred in the German empire, with date, location, kind of boiler, and number of persons injured. 1000 w. Glückauf—Sept. 25, 1897. No. 15863 B.

Locomotive Boiler.

A New Water-Tube Locomotive Boiler. Suggestions of Sweney Munson, a locomotive engineer on the Lehigh Valley R. R., with illustrations and dimensions. 700 w. Ry Mas Mech—Oct., 1897. No. 15666.

Marine Boilers.

Note on the Construction of Locomotive Boilers for Vessels. (Ein Beitrag zur Konstruktion der Schiffs-Lokomotivkessel.) Discussing especially details of fire box construction in adapting the locomotive boiler to marine use. 3500 w. Zeitschr d Ver Deutscher Ingenieure—Sept. 11, 1897. No. 15821 D.

Repairs.

How to Make Light Repairs on the Locomotive Boiler. Henry J. Raps. Suggestions and directions for repairing and caring for boilers. 2800 w. Loc Engng—Oct., 1897. No. 15650 C.

Steam Calorimeters.

Apparatus for Determining Moisture in Steam. (Appareils Servant à Mesurer l'Humidité d'une Vapeur.) Describing various calorimeters, including those of Barrus, Carpenter, Gehre, and Rateau. 2500 w. La Revue Technique—Sept. 10, 1897. No. 15881 D.

Steam Condensation.

Some Experiments on the Condensation of Steam. Read before the British Assn. at

Toronto. Part first considers a new apparatus for studying the rate of condensation of steam on a metal surface at different temperatures and pressures, by H. L. Callendar and J, T. Nicolson ; and part second explains an electrical method of measuring the temperature of a metal surface on which steam is condensing, by H. L. Callendar. 3300 w. Engng—Oct. 15, 1897. No. 16126 A.

Valves.

Large vs. Small Locomotive Valves. Discusses the results of tests carried out on the Chicago & Northwestern locomotive testing plant for the purpose of showing the comparative values of small and large ports on the proportion of the mean effective pressure to the boiler pressure. 1000 w. Am Eng & R R Jour—Oct., 1897. No. 15654 C.

Watertube Boilers.

The Buttner Multitubular Boiler. (Chaudières Multitubulaires Système Buttner.) A combined system of shell and water-tube boiler, intended to unite good steaming qualities with large reserve capacity. 1200 w. La Revue Technique—Sept. 10, 1897. No. 15878 D.

Tests of Water-tube Boilers in the German Navy. (Versuche in der Deutschen Kriegsmarine mit Wasserrohrkesseln.) Giving results of tests of a variety of boilers made at Stettin during the past year including the Thorneycroft, Dürr, Belleville and Niclausse types. Two articles, 3000 w. Zeitschr d Ver Deutscher Ingenieure—Sept. 11 and 18, 1897. No. 15824 G.

COMPRESSED AIR.

Motors.

Reports of Experience with Compressed Air Motors on Elevated and Street Railways. Papers bearing on the economical results obtained with compressed air motors on street railways. A statement from Hermann Haupt, and reports of engineers employed by the Commissioners of the Dist. of Columbia, U. S. A., to examine the system of traction which should be adopted in Washington. Also editorial. 12000 w. Eng News—Oct. 7, 1897. No. 15772.

Postal Tubes.

The Pneumatic Postal Tube, New York. Reviews briefly the history of transportation through closed tubes and gives description, with illustrations, of the pneumatic tube service in process of construction in this city. 3000 w. Eng Rec—Oct. 23, 1897. No. 16127.

Signals.

The Thomas Pneumatic System of Handling Railway Switches and Signals. Illustrated detailed description. The fundamental feature is the manipulation of the valves admitting air to and exhausting it from the working cylinders, by means of pistons of the equalizing type. Ill. 4000 w. Compressed Air—Oct., 1897. No. 16101.

Test.

Test of a Four-Stage Air Compressor at Pressures Up to 2500 lbs. per sq. in. K. E. Stuart and H. L. Terwilliger. Condensed from a graduating thesis at Cornell University, Ithaca, N. Y. Describes plant, plan and theory of test, the testing, and gives conclusions. 4800 w. Eng News—Oct. 7, 1897. No. 15773.

ENGINES AND MOTORS.

Blowing Engine.

Compound Beam Blowing Engine in the Silver and Lead Works at Pribram. (Ueber die Balancier Compound Gebläsemaschine bei der Silber und Bleihütte zu Pribram.) A double beam engine of 75 horse power of good design, with Corliss valve gear. Two articles, 1 plate, 7500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 18, 25, 1897. No. 15861 E.

Engines.

See Electrical Engineering, Lighting. See also Street and Electric Railways.

Engine Trials.

Trials of a Horizontal Compound Tandem Engine. From Mr. Longridge's report to the Engine, Boiler, and Employers' Liability Assn., 1896. Describes the engine and boiler, giving the measurement of feed water and indicator diagrams, with remarks upon the trials. 1800 w. Prac Eng—Oct. 15, 1897. No. 16152 A.

Fuel.

Petroleum Steam-Engine Fuel. J. A. F. Aspinall. Read before the Institution of Civil Engineers (England). Reviews the experiments that have been made and the methods of applying the oil, pronouncing it an ideal method of raising steam, the only difficulty being the cost. 1300 w. Am Eng & R R Jour—Oct., 1897. No. 15655 C.

Heat Motors.

A Discussion of Heat Motor Cycles. (Die Beurteilung der Kreisprozesse von Wärmekraftmaschinen.) An examination of the Carnot cycle by Prof. Meyer, with especial reference to the Diesel heat motor. 8000 w. Zeitsch d Ver Deutscher Ingenieure—Sept. 25, 1897. No. 15824 D.

High Speed.

The Raworth Universal Steam Engine. (Machine à Vapeur Universelle, Système Raworth.) With illustrations of details, and some account of the Raworth high-speed engine as shown at the Brussels Exposition, and installed at Vincennes and at Wandsworth, England. 3500 w. 1 plate. La Revue Technique—October 10, 1897. No. 15597 D.

Mill Engine.

Coupled-Compound Horizontal Mill Engine. Illustrated description of a condensing engine recently erected for driving the large flour mills, known as the "steam mills," in Wolverhampton, England. 800 w. Engr, Lond—Oct 1, 1897. No. 15921 A.

Oil Engine.

The "Diesel" Oil Engine. Illustrated description of the invention of Rudolph Diesel, called a "Rational Heat Motor," as given in the *Zeitschrift des Vereines deutcher Ingenieure*. The summarized translation is by B. Donkin. 4500 w. Engr, Lond—Oct. 15, 1897. No. 16135 A.

Petroleum Motor.

Petroleum Motor for Tricycles. (Moteur à Pétrole pour Tricycle.) The Dion Bouton & Co. motor is operated with vaporized petroleum, on the Otto cycle, with electric ignition. The speed is controlled by varying the air admission. 1500 w. La Revue Technique—Sept. 25, 1897. No. 15583 D.

The New Otto Petroleum Motor. (Nouveau Moteur à Pétrole "Otto.") The principal novelty lies in the valve gear, which is operated by an eccentric, giving much less noise than a gear and cam motion. The petroleum is used as a spray, with tube ignition and the usual Otto cycle. Serial. Part I. 2500 w. Le Génie Moderne—October 15, 1897. No. 16180 B.

Pumping Engine.

See Municipal Engineering, Water Supply.

Regulation.

The Economical Governing of Steam Engines. John S. Raworth. Comparing the relative methods of governing by throttling and by varying cut-off. Willans law is discussed and curves of steam consumption per horse power given for various conditions of load and regulation. 2500 w. Engineering Magazine—Nov., 1897. No. 15593 B.

Testing.

Testing Engines. A consideration of the practical points. 2200 w. Bos Jour of Com—Oct. 16, 1897. No. 16020.

POWER AND TRANSMISSION.

Elevator Accident.

Lessons of the Elevator Accident in the Tract Building, New York City. Editorial comment on the verdict of the coroner's jury and discussion of the cause. 1500 w. Eng News—Sept. 30, 1897. No. 15660.

Water Power.

The Water-Power Resources of the State of Washington. Eleazer Darrow. Illustrated account of some of the undeveloped water powers in this State. 1500 w. Elec Wld—Oct 23, 1897. No. 16167.

SHOP AND FOUNDRY.

Bearings.

Prevention of the Sliding Friction of Ball and Roller Bearings. From *La Nature*. Illustrated description of the invention of B. M. G. Philippe for obviating the sliding friction of rollers. 800 w. Sci Am Sup—Oct. 16, 1897. No. 15958.

Belgium.

A Belgian Engine-Shop. F. J. M. An account of the establishment of H. Bollinckx, of Brussels, Belgium. Ill. 1100 w. Am Mach—Oct. 14, 1897. No. 16001.

Bell Founders.

Bell Founders in England. Interesting information of this industry which dates from mediæval times. 1400 w. Mach, Lond—Oct. 15, 1897. No. 16156 A

Boiler Tools.

Staking and Riveting Tools. A. H. Cleaves. Illustrated description. 500 w. Am Mach—Oct 21, 1897. No. 16097.

Boring Mill.

A Boring-Mill Job as a Trade Secret—Some "Practical" Mathematics. A question regarding the turning of a steel casting is answered, showing it to be a matter of simple mathematics and not a "trade secret." 1100 w. Am Mach—Oct. 7, 1897. No. 15760.

Cost-Keeping.

Cost-Keeping Methods in Machine Shop and Foundry. Henry Roland. The details of several large shops are compared, especially with respect to piece-work rates and the different forms of piece-rate tickets, blanks and records. Forms of order blanks in practical use are given and discussed. 6000 w. Engineering Magazine—Nov., 1897. No. 15590 B.

Crank Pins.

Improved Lubrication of Crank Pins. E. O. Hefford. Brief illustrated description of a device found to give excellent results in practice. 500 w. Prac Eng—Oct. 1, 1897. No. 15935 A.

Electric Driving.

Electricity versus Shafting in the Machine Shop. Charles H. Benjamin. Showing the economic advantages of electricity. 5000 w. Am Gas Lgt Jour—Oct. 4, 1897. No. 15735.

Exposition.

Machinery at the Universal Exposition of 1900. (Les Machines à l'Exposition Universelle de 1900.) B. de Prièue. A discussion of recent progress in machine tool design, urging a full exhibit of French tools at Paris in 1900. 2000 w. La Revue Technique—October 10, 1897. No. 16179 D.

Forge.

Researches upon Forge Fires with Water Spray Blast. (Versuche mit Schmiedefeuern und das Wasserstaubfeuer von Bechem & Post.) Showing the higher efficiency gained by introducing moisture into the blast, with description of the apparatus. 3500 w. Stahl und Eisen—September 15, 1897. No. 15847 D.

Foundry Metals.

Comparative Fusibility of Foundry Metals. Thomas D. West. Read at the Cincinnati meeting of the Western Foundrymen's Assn. Gives tabulated results obtained by the writer and discusses them, and shows the economy and advantages to be obtained by using chilled pig metal in foundries and in Bessemer-steel works. 2000 w. Am Mfr & Ir Wld—Oct. 22, 1897. Serial. 1st part. No. 16147.

Gear Cutter.

A Large Gear Cutter. Describes a gear-cutting machine of unusual size, which has recently been added to the equipment of the Newton Machine Tool Works. 500 w. Am Mach—Oct. 21, 1897. No. 16099.

Grinder.

A New Drill Grinder, Illustrated description of an improved machine invented by O. S.

Walker. 1300 w. Am Mach—Oct. 28, 1897. No 16202.

Hydraulic Press.

Hydraulic Press of 350 Tons Capacity. (Presse Hydraulique de 350,000 Kilogrammes.) A powerful press for hydraulic forging, on the Tenner system, with steam accumulator. 1500 w. La Revue Technique—Sept. 10, 1897. No. 15582 D.

Inspectors.

Instructions to Inspectors at Mills and Shops. J. A. L. Waddell. Twenty suggestions to aid the work of inspectors. 1000 w. Ind Engng —Sept. 18, 1897. No. 16110 D.

Laps.

Laps. Explains the usefulness of these tools and the advantage of having a set in the average shop, giving illustrations of the work. 3500 w. Am Mach—Oct. 7, 1897. No. 15759.

Lathes.

Alignment of Engine Lathes. S. Ashton Hand. The object of the article is to show how athes should be aligned in the process of building and also to enable owners of lathes to test them properly for accuracy. Ill. 900 w. Mach, N Y—Oct., 1897. No. 15745.

Machine Tools.

Machine Tools from Another Point of View. J. W. Gardner. Reference is made to a paper presented by William Forsythe on this subject, and a discussion of the way to get any reliable nformation of the efficiency of machine tools, with statement of the conditions existing in ailroad shops. 1800 w. Ry Mas Mech—Oct., 1897. No. 15667.

Molding Machinery.

A Modern Foundry. An account of a visit o the Worthington foundry at Elizabethport, N. J., describing the work, and calling attention to the general use of the molding machine. 2000 w. Am Mach—Oct. 7, 1897. No. 15761.

Molding Sand.

Molding Sand. D. H. Truesdale. Read at he Cincinnati meeting of the Western Foundrymen's Assn. Discusses the necessary elements of molding sand and the proportions needed in combination. Considers refractory qualities, porosity, fineness and a sufficient bond. 1200 w. Am Mfr & Ir Wld—Oct. 22, 1897. No. 16148.

Physical Tests.

The Value of Physical Tests. S. S. Knight. Read before the Western Foundrymen's Assn. at Cincinnati. Discusses this subject and concludes that physical tests will be found valuable only as they are made on reliable apparatus, and that no system of testing will equal the ingenuity of a trained and competent man, with facilities to use his knowledge. 3000 w. Ir Age—Oct. 21, 1897. No. 16076.

Planing Machine.

A Large Post-Planing Machine. Illustrated description of a machine made by Bement, Miles & Co., for the Bethlehem Iron Works. 700 w. Am Mach—Oct, 21, 1897. No. 16098.

Rubber Factory.

The Works of the Peerless Rubber Manufacturing Company, New Durham, New Jersey. Illustrated description of the process as practiced by this company. 3000 w. Am Eng & R R Jour—Oct., 1897. No. 15651 C.

Springs.

Cylindrical Spiral Springs. George. R. Bale. Diagrams, giving dimensions of cylindrical spiral springs for given loads, limiting the stress on the material to 16-tons per square inch, with explanations. 1300 w. Mech Wld—Oct. 8, 1897. No. 16052 A.

Steel Tubing.

The Steel Pipe and Tube Industry. Illustrated detailed description of the work as carried on by the National Tube Works Co. 2500 w. Sci Am—Oct. 23, 1897. Serial. 1st part. No. 16081.

Tubes.

The Manufacture of Iron Boiler Tubes. (Fabrication des Tubes à Fumée en Fer.) Describing the Boulet system of making lap welded boiler tubes, with illustrations of the machines and description of the methods of testing the finished product. 3000 w. Le Génie Civil—Sept. 11, 1897. No. 15816 D.

Turret Lathe.

The Home of the Flat Turret Lathe, Illustrated description of the shops and work of the Lamson Machine Company, at Springfield, Vt. 2000 w. Mach, N Y—Oct., 1897. No. 15746.

Vents.

Lighting Vents in the Foundry. R. Watson, in *Iron Moulders' Journal.* Considers the general practice a mistake and gives reasons. 1000 w. Prac Eng—Oct. 8, 1897. No. 16068 A.

MISCELLANY.

Automobiles.

Methods of Obtaining Motive Power for Motor Carriages. A free translation of an article by Marcel Deprez, from *Génie Civil.* Gives statement compiled by M. Barbet on the Mékarsky system, discusses the use of liquified gases, of hot-water under pressure, &c. 2000 w. Automotor—Oct., 1897. No. 16154 A.

The "Heavy Weights" Competition of the Automobile Club. From *La Nature.* An account of the international competition which recently took place in Paris, with illustrations of the principal types of the vehicles that competed. 1300 w. Sci Am Sup—Oct. 9, 1897. No. 15769.

Belts.

A New Formula for Determining the Width of Leather Belting. John J. Flather. Presented before Sec. D, Am. Assn. for the Advancement of Science, Detroit. Gives formula with additional information. 2200 w. Am Mach—Oct. 28, 1897. No. 16204.

Balloon.

The Aeronautic Expedition of M. Andrée to the North Pole. (L'Expedition Aeronautique de M. Andrée au Pôle Nord.) With photographic views of the buildings, gas generators and apparatus pertaining to the protection and inflation of the balloon. 2500 w. Le Génie Civil—Aug. 21, 1897. No. 15809 D.

Bicycles.

The Chainless Bicycle. Report of the efficiency tests by Professor Denton, made for the Pope Manufacturing Co., giving detailed data, method, description, &c., with general conclusions. 4500 w. Ir Age—Oct. 21, 1897. No. 16075.

The Columbia Chainless Bicycle. Illustrated description of the mechanical details of the driving gear, and of the machine which has been designed for cutting the epicycloidal teeth of the bevel gears. 1200 w. Sci Am—Oct. 30, 1897. No. 16174.

The Columbia Chainless. Russell Stone. Illustrated description and the history of the invention. 4500 w. McClure's Mag—Nov., 1897. No. 16226.

Compression Tests.

The Resistance of Bars to Compressive Forces. (Résistance des Barres Soumises à des Efforts de Compression.) M. Dupuy. A record and discussion of a large number of official tests of steel bars, with tables and diagrams. The Klein Elasticimeter was used. 25000 w. Two plates. Ann Des Ponts et Chaussées—Pt. I, 1897. No. 15867 F+G.

Elevator Accident.

Elevator Accident in a New York Hotel. Brief account of the falling of an elevator in Hotel Waldorf which injured two employee, and badly damaged the car. 400 w. Eng Rec—Oct. 16, 1897. No. 16056.

Engineering.

The Engineering Industry in the States. Compares American workmanship and methods with the English, showing the disadvantages under which the latter labor, and the benefits in the United States from labor-saving machinery. 1500 w. Mach, Lond—Oct. 15, 1897. No. 16157 A.

Galvanizing.

On an Improvement in the Art of Galvanizing. George C. Reese. The object of the paper is to call attention to a recent advance in the art of galvanizing, by which many objectionable features are obviated, insuring greater rapidity, better quality, economy, and resulting in new forms of coated material. Ill. 2000 w. Jour Fr Inst—Oct., 1897. No. 15779 D.

Graphics.

The Use of the Graphical Method in Experimental Science (La Methode Graphique et les Sciences Expérimentales.) Portion of an address by M. Marey upon the value of mechanically recording devices in experimental investigations. 1500 w. Le Génie Moderne—Sept. 15, 1897. No. 15832 B.

High Temperatures.

Some Modern Devices for Securing High Temperatures. W. H. Birchmore. A résumé of the variety of appliances used for this purpose, as seen and studied by the writer. 5000 w. Am Gas Light Jour—Oct. 4, 1897. No. 15734.

Lubrication.

Lubrication. George L. Fowler. A few suggestions as to the considerations that should have weight in making a selection of lubricants and bearing metals to be used on cars. 3800 w. Ry Mag—Sept., 1897. No. 16160 C.

Roller Bearings.

See Railroad Affairs, Maintenance of Equipment.

Rotation.

Some Phenomena of High-Speed Rotation. James F. McElroy. Abstract of a paper read before the Albany Institute. Illustrated description of phenomena observed while engaged in the development of a steam turbine running at very high speeds. 1700 w. Elec Wld—Oct. 16, 1897. No. 16050.

Speed Indicator.

Electro-Magnetic Speed Indicators. (Les Tachymètres Electro-Magnetiques.) The Abdank-Abankowicz speed indicator acts by the angular displacement of a metallic disk by a revolving magnet. 1500 w. La Revue Technique—Sept. 10, 1897. No. 15880 D.

Testing.

International Association for Testing Materials of Construction. (Internationaler Verband für die Materialprüfung der Technik.) A report of the meeting of the International Association held at Stockholm in August, with discussion of papers. 8000 w. Stahl und Eisen—Sept., 15, 1897. No. 15848 D.

The Influence of Testing upon the Resistance to Bending at Lower Temperatures. (Einfluss des Prüfungs verfahrens auf das Ergebniss der Biegeproben bei niederen Wärmegraden.) A review of Prof. Rudeloff's tests at the Charlottenburg laboratory. Both bending and drop tests were made. 4500 w. Stahl und Eisen—Sept. 1, 1897. No. 15844 D.

The Results of Tests for Rupture. (Ueber Ergebnisse von Zerreiss versuchen.) A discussion by Herr Knaudt, of some elongation and rupture tests made at the Charlottenburg laboratory, with a rejoinder by Prof. Martens. 3000 w. Zeitschr d Ver Deutscher Ingenieure—Sept. 25, 1897. No. 15825 D.

Tool Grinding.

Systematic Tool-Grinding. Illustrated description of method observed in a shop in Leipzig, Germany. 1000 w. Am Mach—Oct. 28 1897. No. 16203.

Tools.

Machine Tools. Editorial on the development of the automatic tool in England, sure to follow the present dispute in the engineering trade. 1300 w. Engr, Lond—Oct. 8, 1897. No. 16031 A.

Type Setting.

Machine Substitutes for the Composition of Types by Hand. Harold M. Duncan. Deals with the machines which have reached commercial stages, from the standpoint of principles. Considers the operations and requirements of good printing. Ill. 11000 w. Jour Fr Inst—Oct., 1897. No. 15778 D.

MINING AND METALLURGY.

COAL AND COKE.

Anthracite.

The Competition Against Anthracite Coal. rom the monthly letter of the Anthracite Coal perators' Assn. A statement of the condi- ions of to day and their effect on the anthracite oal trade. 2300 w. Ir Age—Oct. 14, 1897. o. 15956.

Briquettes.

Briquettes and Briquette Machinery. Philip . Björling. Describes the making of bri- uettes and the various binding materials used, aming the qualities they should possess, and e mechanical processes through which the aterial must pass. Ill. 3500 w. Col Guard— ept. 24, 1897. Serial. 1st part. No. 15693 A.

Cannel.

An Austrian Cannel Seam. R. Danilof, in *esterreichische Zeitschrift für Berg-und Hüt- enwesen*. An account of the location, thick- ess, quality, &c. 900 w. Col Guard—Sept. 4, 1897. No. 15697 A.

Coal Analysis.

Ultimate Analysis of Coal. F. Haber and S. rinberg, in *Zeitschrift für Analytische-Chemie*. escribes the method of analysis which has een used for some time at the experimental sta- ions at Munich and Karlsruhe. 1300 w. Col. uard—Oct. 15, 1897. No. 16131 A.

Coal Ash.

The Relation between Composition and Fusi- ility in Coal Ash. Report of investigations ade. 1500 w. Col Guard—Oct. 1, 1897. No. 5916 A.

Coal Formation.

The Manner of Coal Formation. G. Schmitz. rom a communication to the *Revue des Ques- ions Scientifiques*. Presents the arguments of M. F. Rigaud in proof of coal being an erup- ive rock and the difficulties in connection with he theory. 1700 w Col Guard—Oct. 1, 1897. No. 15915 A.

Coal Measures.

Belgian Coal Measure Museum. From a rochure issued, in connection with the Brussels International Exhibition, by G. Schmitz. In- ormation of the coal formation, and stating he object of the museum, and the arrangement f the specimens. 3000 w. Col Guard— Oct. 15, 1897. No. 16132 A.

The Permo-Carboniferous Boundary. C. E. De Rance. Read before the Manchester Geological Society. A study of the coal measures in England. 4800 w. Col Guard—Oct. 1, 1897. No. 15917 A.

Coal Statistics.

The Production, Value and Distribution of Coal in 1896. Tabulated statements and discussion of the coal industry of the United Kingdom. 1500 w. Col Guard—Sept. 24, 1897. No. 15694 A.

Coal Trade.

See same title under Economics and Industry, Commerce and Trade.

Faults.

A Peculiar Formation. George W. Engel. A description of a peculiar fault in the Mammoth coal bed, Panther Creek Basin, Pennsylvania. 700 w. Col Eng—Oct., 1897. No. 16012 C.

France.

Colliery Development in the North of France. F. Colomber, in *La Revue Technique*. Describes the sinking of a new shaft in the Pas-de-Calais district, which has greatly increased the output, and the development of the working area. 1500 w. Col Guard—Oct. 8, 1897. No. 16032 A.

Mechanical Installations.

Underground Mechanical Installations at a Belgian Colliery. Edm. Briart. Describes and illustrates the installations made at St. Catherine Pit of the Bascoup Colliery, in Belgium. 2000 w. Col Guard—Sept. 24, 1897. No. 15698 A.

Nova Scotia.

Analysis of Nova Scotia Coals and other minerals. E. Gilpin, Jr., Gives analysis made by J. T. Donald, taken from the workings at a depth of 800 to 1000 feet. Compares them with analysis made by the writer about 1880, and briefly considers iron and other ores. 1000 w. Can Eng—Oct., 1897. No. 15982.

Ownership.

Reputed Ownership as Regards Colliery Machinery, Plants and Coal. Cases decided by the English superior courts bearing upon the bankruptcy law. 1600 w. Col Guard—Oct. 8, 1897. No. 16033 A.

Safety Lamps.

Thermo-Electric Magnetism and Mining Safety-Lamps. Describes a singular case of thermo electric magnetism in a safety-lamp, and the investigations of the cause. 2500 w. Col Guard—Sept. 24, 1897. No. 15695 A.

South Africa.

The South Rand Coalfield. A. R. Sawyer. Extract from a paper read before the Federated Inst. of Mining Engs. Describes this portion of the South African formation, which the writer explored personally and in which he discovered a very valuable coal-seam. 2400 w. Col Guard—Sept. 24, 1897. No. 15700 A.

South Russia.

The South Russian Iron and Coal Industries. Professor Thimé. Translated by G. Kamensky. Information of coal mines and iron works gathered on a recent journey, and intended to illustrate the actual condition of these industries in the region named. 3200 w. Col Guard—Oct. 15, 1897. Serial. 1st part. No. 16130 A.

Subsidence.

Subsidence Caused by the Workings in Mines. W. Galloway. Read before the South Wales Institute of Engineers. Gives views and observations relating to this subject by eminent engineers, considering also certain phenomena which help to an understanding of the subject. 4200 w. Col Guard—Sept. 24, 1897. Serial. 1st part. No. 15696 A.

Thin Seams.

The Working of Thin Horizontal Seams in England. (Abbau Minder Mächtiger, Flachliegender Flötze in England.) Hans Gutmann, Describing the "board and pillar," and "long wall" systems of coal mining as seen by a German engineer. Two articles, 1 plate. 7500 w. Oesterr Zeitschr f Berg u Hüttenwesen—September 4, 11, 1897. No. 15859 E.

Winding.

Winding from Great Depths with Constantly Balanced Ropes. André Desprès. Describes the means for practically carrying out this system, giving illustrations. 2800 w. Col Guard—Sept. 24, 1897. No. 15692 A.

COPPER.

Lake Superior.

Atlantic Copper Mine, Houghton County, Michigan. Theodore Dengler. Read before the Denver Society of Civil Engs. General information of the copper mines of the Lake Superior region with special consideration of the Atlantic Mine. 2500 w. Jour Asso of Eng Soc—Sept., 1897. No. 15994 C.

GOLD AND SILVER.

Alabama.

Some Auriferous Quartz Bodies in Alabama, W. M. Brewer. Describes the occurrences of gold-bearing ores in Alabama, with suggestions and general information. 1400 w. Eng & Min Jour—Oct. 16, 1897. No. 15999.

Appalachian.

The Southwestern Extremity of the Appalachian Gold-Fields. William B. Phillips. Thinks there is but little hope of the placers of this part of the United States and that money spent should be devoted to the quartz seams. 1500 w. Eng & Min Jour—Oct. 2, 1897. No. 15679.

Cyanid.

Cyanid Solutions for Leaching Auriferous Ores and Tailings. Walter J. Studds. Describes the solution as applied on the Coolgardie goldfields. 1000 w. Aust Min Stand—Sept. 16, 1897. No. 16171 B.

Notes on the Action of Potassium Zinc Cyanid Solutions on Gold. W. J. Sharwood. The views of various writers as to the nature of the chemical changes taking place during solution are reviewed in part first. 1200 w. Eng & Min Jour—Oct. 2, 1897. Serial. 1st part. No. 15678.

Dredging.

Placer-Mining Dredges on Grasshopper Creek, Montana. Illustrated description of the ladder dredge used for this work. 1000 w. Eng News—Oct. 14, 1897. No. 15970.

Georgia.

Gold Mining in Georgia. F. H. Richardson. An account of the extent of the operations in progress and projected. 2000 w. Mfrs Rec—Oct. 15, 1897. No. 16016.

Golden Age.

Gold: The Coming Golden Age. Almarin B. Paul. Extracts from an address before the California Pioneer Assn. Presents the history of the increase in volume of the world's gold since its discovery in California, with reasons and expectations for the future. 1400 w. Min & Sci Pr—Oct. 23, 1897. No. 16206.

Gold Dredger.

The Ball Gold Dredger. Describes a combination dredger and gold saver in use in South Africa and in Madagascar. 2300 w. Engr, Lond—Oct. 8, 1897. No. 16027 A.

Gold Tax.

Gold Export Tax in Nicaragua. Consular report of a decree establishing an export duty of $1 (gold) per ounce on gold ingots and $2 (gold) per ounce on gold dust. 900 w. Cons Repts—Oct. 23, 1897. No. 16153 D.

Klondike.

Placer Mining in the Klondike Country. Brief description of the region and the methods of working. 1000 w. Eng & Min Jour—Oct. 9, 1897. No. 15907.

The Klondike Gold-Fields. H. Bratnober. A description of the placers, and the conditions found, by one who has just returned from Alaska. 1200 w. Eng & Min Jour—Oct. 23, 1897. No. 16111.

Manchuria.

The Gold Deposits of Manchuria. M. René de Batz in the *Génie Civil*. Some particulars with regard to these deposits, with map showing proposed Eastern Chinese railroad. 1500 w. Eng & Min Jour—Oct. 16, 1897. No. 15998.

Ontario.

The Gold-Fields of the Rainy River District. Horace V. Winchell. Comments on the salient features of the Rainy-Lake and Seine river portions of this large district in Western Ontario. Map. 2800 w. Eng & Min Jour—Oct 23, 1897. No. 16112.

Russia.

The Gold Mines of the Russian Empire. (Les Mines d'or de l'Empire Russe.) An illustrated account of the gold mines of the Ural and of Siberia, with statistics, methods of working and prospects with the introduction of railways. Two articles, 1 plate. 6000 w. Le Génie Civil—July 24, Aug. 7, 1897. No. 15800 G.

San Juan.

The Needles. Arthur Lakes. A report of a recent exploring excursion to the Needles region of the San Juan in Colorado. A description of the peculiar formations and appearance of the country and some suggestions in regard to its possibilities as an ore-producing region. Ill. 2200 w. Col Eng—Oct., 1897. No. 16013 C.

Tasmania.

The Lefroy Goldfields, Tasmania. Leslie Jolly. A descriptive paper, based on absolute facts that have come within the knowledge of the writer. 2400 w. Aust Min Stand—Sept. 9, 1897. No. 16026 B.

Veins.

Vein Occurrence. Arthur Lakes. A study of vein formation as illustrated in Clear Creek cañon, Colorado. Ill. 1200 w. Col Eng—Oct., 1897. No. 16014 C.

IRON AND STEEL.

Armor Plates.

The Attack of Harveyed Armor-Plates by Armor-Piercing Projectiles. A table giving results obtained against treated armor of the highest class, with discussion of the same. 1500 w. Engr, Lond—Oct. 15, 1897. No. 16134 A.

The Witkowitz Armor-Plate Tests. (Tir d'Essai contre des Plaques de Blindage à l'Usine de Witkowitz.) A full account of the Austrian armor-plate tests, with photographs of the action of projectiles upon steel plates, Harveyized and non-Harveyized, also plates of nickel steel. 3000 w. La Revue Technique—October 10, 1897. No. 16177 D.

Blast Furnace.

The "Kraft" Iron Works. (Das Eisenwerk "Kraft.") Illustrated description of these new works at Kratzniek, near Stettin, on the Oder, with plate of blast furnace details. 3500 w. Stahl und Eisen—September 1, 1897. No. 15841 D.

Cooling.

The Influence of Sudden Cooling on Nearly Pure Iron. Albert Sauveur. A reply to paper by J. O. Arnold on the same subject. 1000 w. Eng & Min Jour—Oct. 23, 1897. No. 16113.

Edison Mines.

Edison Ore Mines. An interview with Mr. Edison with a description of works and processes. 3000 w. Elec Rev, N Y—Oct. 27, 1897. Also Ir Age—Oct. 28, 1897. No. 16200.

Edison's Revolution in Iron Mining. Theodore Waters. Illustrated description of the new application of electricity. 8500 w. McClure's Mag—Nov., 1897. No. 16227.

Microscopy.

The Microscopic Inspection of Steel. Francis Scott Rice. Notes of experience in the microscopic examination of steel. Ill. 1700 w. Eng News—Oct. 28, 1897. No. 16207.

Nickel Steel.

Nickel Steel. C. E. Guillaume. Translated from *Comptes Rendus*. A study of these alloys, giving results. 700 w. Am Mfr & Ir Wld—Oct. 15, 1897. No. 16022.

Open Hearth.

Charging Devices for Open Hearth Furnaces. (Beschickungsvorrichtungen für Martinöfen) Principally illustrating the Wellman electric charging machine as used in Germany, with photographs of the device at the Lauchhammer Works. 5000 w. Stahl und Eisen—September 1, 1897. No. 15842 D.

Ore Loading.

Iron Ore Loading on the American Great Lakes. H. J. Slifer. With illustrations of the apparatus and harbor facilities by means of which about ten million tons of iron ore are handled in a season, in the Lake Superior region. With maps of the Gogebic Iron Region. 3000 w. Engineering Magazine—Nov. 1897. No. 15595 B.

Production.

Iron Ore and Pig Iron Production in 1896. Report of the United Kingdom compiled from the *Mineral Statistics*. 2000 w. Col Guard—Oct. 1, 1897. No. 15918 A.

Southern Mines.

Southern Iron Mining. William M. Brewer. A description of the iron ore mines of Alabama and Georgia. The methods of mining red hematite and brown limonite and manganese ores and the different processes of washing and preparing them for the furnace. Ill. 4000 w. Col Eng—Oct., 1897. No. 16011 C.

South Russia.

See also Coal and Coke.

Steel Tubing.

See same title under Mechanical Engineering, Shop and Foundry.

Sweden.

A Review of the Development of the Iron Industry in Sweden. (Einige Hauptzüge der Entwicklung der Eisenindustrie in Schweden.) A paper presented by Axel Whalberg before the international congress for testing materials at Stockholm. 2500 w. Stahl und Eisen—September 1, 1897. No. 15845 D.

Thermo-Chemistry.

A Preliminary Thermo-Chemical Study of Iron and Steel. E. D. Campbell and Firman Thompson. A paper presented to the American Chemical Society. Describes work undertaken to determine whether carbon alone was responsible for the variations in the heat of solution of steel subjected to different heat treatments. 3300 w. Ind & Ir—Oct. 1, 1897. No. 15934 A.

Vickers' Works.

Vickers' Works at Sheffield, England. Historical account and illustrated detailed description. 3800 w. Engng—Oct. 1, 1897. Serial. 1st part. No. 15912 A.

MINING.

Accidents.

The Fatal Accidents in the Prussian Mines in 1896. (Verunglückungen mit Tödtlichem Ausgange beim Bergwerksbetriebe Preussens während des Jahres 1896.) With tabulated results from 1891 to 1896, and a general review of the nature and causes of the disasters. 2000 w. Glückauf—September 25, 1897. No. 15865 B.

Aluminum.

Processes in the Metallurgy of Aluminum Developed in 1897. (Procédes Mis en Oeuvre en 1897 dans la Métallurgie de l'Aluminum.) Alfred Boudon. The first of a series describing the most recent advances in the isolation of aluminum, as well as some new alloys. Serial, Part I. 3000 w. La Revue Technique—October 10, 1897, No. 15598 D.

Cobalt.

The Cobalt Deposits in the Westerwald. (Das Kobalt-Vorkommen in Westerwalde.) Giving an account of the manganiferous cobalt deposits in Rhenish Russia, and suggesting possible uses of the metal and its compounds. 2500 w. Glückauf—October 2, 1897. No. 15866 B.

Creeps.

The Control of Creeps. Edward Jones. Methods of working coal seams in Northern Illinois which control creeps and avoid crushes. Describes some of the requirements for a successful system, and the precautions necessary in laying out and carrying on the work. Ill. 2000 w. Col Eng—Oct., 1897. No. 16015 C.

Locomotive.

New Compressed Air Mining Locomotive. Illustration, with brief description of an air motor made by the Dickson Manufacturing Co., for the D. & H. Canal Co. 750 w. R R Gaz—Oct. 29, 1897. No. 16218.

Lead Smelting.

The Application of Tin Plate Scrap in Lead Smelting. (Verwerthung von Weissblechabfällen in Bleihüttenbetriebe.) A paper by Dr. August Harpf describing his process for using tin plate cuttings in the reduction of lead. Two articles. 6000 w. Oesterr Zeitschr f Berg u Hüttenwesen—August 14, 21, 1897. No. 15858 E.

Measurements.

Survey Measurements of Steep Drivages. Joh. Nemecek, in *Oesterreichische Zeitschrift für Berg-und Hüttenwesen.* Illustrated description of methods suggested. 900 w. Col Guard—Sept. 24, 1897. No. 15691 A.

Methane.

The Determination of Methane in Mine Gases. (Uber die Bestimmung des Methans in der Grubenluft) E. Hankus. Showing the variation in the percentage of Methane for different barometric pressures, and giving the results of analyses. 800 w. Oesterr Zeitschr f Berg u Hüttenwesen—October 2, 1897. No. 15862 B.

Mexico.

The Operation of a Mexican Mine. (Einrichtungen einer Mexicanischen Erzgrube.) Descriptive account of a visit to a typical Mexican mine in the Sierra Madre. 3500 w. Glückauf—September 11, 1897. No. 15853 B.

Quarrying.

Some Modern Appliances for Quarrying and Manipulating Stone. William L. Clements. Considers the conditions reached in the advancement of this work, by the introduction of new machinery. Ill. 3500 w. Stone—Oct., 1897. No. 16102 C.

Quicksilver.

The St. Anna Quicksilver Mine and Works in Krain. (Das Quecksilber Berg- und Hüttenwerk zu St. Anna in Oberkrain.) Describing the successful reopening and extension of these old abandoned workings. Two articles. 5000 w. Oesterr Zeitschr f Berg u Hüttenwesen—September 11, 18, 1897. No. 15860 E.

Safety Catch.

New Safety Catch for Mine Cages. From a communication by E. Flemming to *Glückauf,* of Essen-an-der-Ruhr. Illustrated description of the brake action safety catch brought out by Gerlach and Bömcke, of the Dortmund Ironworks, Westphalia, with report of trials. 1500 w. Col Guard—Oct. 8, 1897. No. 16035 A.

Surveying.

A Method of Surveying in Inclined Shafts. (Zur Markscheiderischen Vermessung Steiler Schächte.) Describing a practical method for doing accurate theodolite work in shafts inclined at angles of about 70°. 1500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—August 21, 1897. No. 15857 B.

Ventilation.

Some Notes on Mine Ventilation by Furnace. H. W. Halbaum. Describes a ventilating furnace at a large colliery in the north of England, which convinced the writer that in some instances it is better policy to ventilate a mine by means of a furnace rather than a fan, even where a large volume of air is required. 5000 w. Col Guard—Oct. 8, 1897. No. 16034 A.

MISCELLANY.

Firedamp.

Explosives and Firedamp in France. (Les Explosifs et le Grisou en France.) Describing the experiments made by a special commission of experts as to the effect of various mining explosives in igniting mine gases. The explosives were discharged in chambers containing the gases. Two papers. 5000 w. Le Génie Civil—August 7 & 14, 1897. No. 15806 G.

Explosives and Firedamp in Germany. (Les Explosifs et le Grisou en Allemagne.) A review of the Neunkirchen experiments for testing the effect of explosives in igniting firedamp in mines. Two articles. 5000 w. Le Génie Civil—September 25, October 2, 1897. No. 16183 G.

Firedamp and the Means of Preventing Accidents in Mines. (Le Grisou-Moyens de Prevenir les Accidents dans les Mines.) Dealing with the rate of production of gas and the proper degree of ventilation necessary for safety. Serial. Part I. 1800 w. Le Génie Moderne—October 15, 1897. No. 16181 B.

Gas Barrier.

Wagner's Portable Gas Barrier for Mine Gangways. (Wagner's Transportabler Wetterdamm für Bergwerke.) An inflatable air cushion used to close off any portion of a mine containing firedamp or smoke. With numerous illustrations showing the method of application. 3000 w. Glaser's Annalen—Oct. 1, 1897. No. 16190 D.

Metallurgy.

Notes on the Present Western Practice of Metallurgy—Economically Considered. W. B. Devereux. General considerations, with an outline of the more recent metallurgical tendencies and practice. 8500 w. Sch of Mines Quar—July, 1897. No. 16161 D.

Mineral Oils.

The Action of Sulphuric Acid on Mineral Oils. R. Zaloziecki. Translated from the German. Gives results of investigations. 800 w. Am Mfr & Ir Wld—Oct 15, 1897. Serial. 1st part. No. 16021.

Mine Transmission.

See Electrical Engineering, Power.

Onyx.

Onyx Beds in Kentucky. From the St. Louis *Star*. Report of the discovery of the richest and most extensive beds of onyx ever known to exist. 1000 w. Arch & Build—Oct. 2, 1897. No. 15747.

Porphyry.

The Porphyry Dike Mines of Montana. L. A. Sisley. Describes the location, geology, workings, ore, &c. 1200 w. Eng & Min Jour—Oct. 2, 1897. No. 15680.

Smelting.

Pyritic Smelting. W. L. Austin. Abstract of a paper read before the North of England Institute of Engineers. A smelting process aiming to utilize the calorific power of the combustible in the ore. Considers what ores are adapted, the style of furnace, the concentration and saving. 4300 w. Col Guard—Oct. 15, 1897. No. 16133 A.

Tin Deposits.

The Tin Deposits at Temescal, Southern California. Harold W. Fairbanks. Detailed description of the veins and the country in which they are found. 1500 w. Min & Sci Pr—Oct. 16, 1897. No. 16096.

Wire Ropes.

The Statistics of Wire Ropes in Mine Hoists. (Statistik der Schachtförderseile.) Giving interesting data about the life of hoisting cables of various kinds, percentage of breakages from 1882 to 1896, and other information, chiefly from the Breslau mining district. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—August 7, 1897. No. 15855 B.

Statistics of the Wire Ropes in the Dortmund Mining District for 1896. (Statistik der Schachtförderseile im Oberbergamtsbezirk Dortmund für das Jahr 1896.) With tabular data from 1872 to 1896, showing the life and efficiency of various makes of wire ropes. 1000 w. Glückauf—September 11, 1897. No. 15864 B.

Ventilation.

Investigations upon Carbonic Oxid in Confined Air. (Rercherche de l'oxide de Carbone dans l'Air Confiné.) Including the use of the "grisoumetre" of Dr. Grehant for determining the proportion of the gas in the air. 3500 w. Le Génie Civil—July 24, 1897. No. 15801 D.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Calcium Carbid and Acetylene Gas. Consular reports from C. H. Day, of Berlin, and Consul-General Mason, of Frankfort. Gives history of calcium carbid, its production and properties, and discusses the use of acetylene gas. 3800 w. Cons Reports—Nov., 1897. No. 15924 D.

The Use of Acetylene. A. H. Mulliken. Abstract of a paper read before the Fire Underwriters' Assn. of the Northwest, at Chicago. Arguing that it is not a dangerous gas, and will surely find its place. 1300 w. W Elect'n—Oct. 9, 1897. No. 15940.

The Use of Acetylene for the Production of Motive Force. P. Chevillard. Describes experiments by Cuinat showing it possible to obtain a regular working with acetylene, and the cost. 1400 w. Pro Age—Oct. 15, 1897. No. 16019.

Address.

Address of J. Holliday, President of the North of England Gas-Managers' Association. A general review of the industry, the changed conditions, and outlook. 4500 w. Jour Gas Lgt—Oct. 5, 1897. No. 16002 A.

By-Products.

The Sale of Sulphate of Ammonia. Norton H. Humphreys. Discussion of the best way to popularize the use of this product as a fertilizer. 2700 w. Jour of Gas Lgt—Sept. 28, 1897. No. 15764 A.

Cyanogen.

Notes on Cyanogen in the Manufacture of Coal Gas. M. G. Perthius. Gives results of some experiments made by the author on the production of cyanogen in retorts. 900 w. Gas Wld—Oct. 16, 1897. No. 16141 A,

Distribution.

The Distribution of Gas. D. Coats Niven. Remarks on two recent papers on this subject, one American, the other, English. 1200 w. Jour Gas Lgt—Oct. 12, 1897. No. 16079 A.

Exhausters.

The Automatic Regulation of the Speed of Exhausters. Matthew Dunn. Read before the North of England Gas-Managers' Assn. Describes an appliance, and its working, proved to automatically regulate the speed of exhausters when driven either by gas or steam engines. Also discussion. 6800 w. Jour of Gas Lgt—Oct. 5, 1897. No. 16003 A.

Explosions.

Certain Phenomena of Gas Explosions. W. H. Birchmore. Describes experiments, and attempts at experiments, which show that the mechinism of gas explosion is a much more complicated process than is commonly assumed. 4500 w. Am Gas Lgt-Jour—Oct. 11, 1897. No. 15906.

Gas Manufacture.

Some Practical Observations on Gas Manufacture. S. Carpenter. Suggestions offered in the hope that they may be of service to those who have attained responsible positions in gas works because of natural ability rather than liberal education. Deals with the production and purification of gas. 2700 w. Jour of Gas Lgt—Sept. 21, 1897. No. 15647 A.

Gas Supply.

I. New York City Should Own the Gas Supply. Edward M. Grout. II. No Government Should Operate an Industry—A Reply. Allen Ripley Foote. III. A Rejoinder. Edward M. Grout. Papers written at the request of the Committee on Municipal Administration of the Reform Club of New York, presenting the pro and con of this question. 23800 w. Munic Af—June, 1897. No. 15951 C.

Meters.

Amalgamation of Meter Makers. Reports the union of four companies in the North of England, and gives a short account of the origin, progress and present position of each. 1500 w. Gas Wld—Sept. 25, 1897. No. 15712 A.

Philadelphia.

The Philadelphia Gas Works. Clinton Rogers Woodruff. A statement of the condition of gas affairs in this city. 2700 w. Harper's Wk—Oct. 16, 1897. No. 15942.

Retorts.

The Kemmerling System of Mechanical Chargers and Drawers for Gas Retorts. G. Velleman. A description of the Kemmerling apparatus which has been used for four years at Kalk with complete success. Translated from *Revue Universelle des Mines, &c.* 5500 w. Pro Age—Oct. 1, 1897. No. 15743.

SEWERAGE.

Construction.

Improved Method of Sewer Construction. (Nouveau Mode de Construction des Souterrains.) M. Bechmann. Describing the improved method of tunneling under city streets without disturbing the surface, using shields operated by hydraulic cylinders, as employed in the new Clichy sewer at Paris. 10000 w. 1 plate. Ann des Ponts et Chaussées—Part I. 1897. No. 15871 F+G.

House Drainage.

The Principle of Delivering all Drainage into the Sewer. (De l'Application du "Tout-à-l'Egout.") A discussion of the importance of doing away with cesspools and wells and the delivery of everything to the sewer, accompanied by an ample flow of water for flushing and dilution. 2500 w. Le Génie Civil—Oct. 9, 1897. No. 16186 D.

Paris.

The Aqueduct and Sewage Farm at Achères. (L'Aqueduct et le Parc Agricole d'Achères.) A very complete and fully illustrated account of this great sewerage work at Paris. 70000 w. 10 plates. Ann des Ponts et Chaussées—Part II. 1897. No. 15873 F+G.

Purification.

Plans for the Sewage Purification Plant at Spandau. (Entwurf zur Kanalwasser-Reinigungs-Anlage für Spandau.) Describing the pumping, settling and purifying plant intended to permit the discharge of the sewage of the city into the Havel; the oxid of iron process is the method adopted. 4500 w. Gesundheits-Ingenieur—Sept. 15, 1897. No. 15840 B.

Sewage Disposal.

Sewage Disposal on Land at Litchfield, Conn. Information of a satisfactory system. 500 w. Eng News—Oct. 28, 1897. No. 16213.

Sewer Gas.

Deadly Sewer Gas. Report of William Attlesey on the disaster in Newport, Ky., which caused destruction of life and property. 1800 w. Dom Engng—Oct., 1897. No. 16043 C.

STREETS AND PAVEMENTS.

Artificial Stone.

Artificial Stone Pavements. Robert Grimshaw. Describing the present state of the art in Europe. 1000 w. Munic Engng—Oct., 1897. No. 15728 C.

St. Louis.

Pavements for City Streets. Sectional views of streets in St. Louis, showing the method of construction adopted in laying the various forms of pavement. Also specifications. From a pamphlet issued by the street commissioner of St. Louis, Missouri. 4000 w. Sci Am Sup—Oct. 9, 1897. No. 15768.

Street Cleaning.

The Labor Question in the Department of Street Cleaning of New York. George E. Waring, Jr. Explains the features of the scheme which has proved a most gratifying success in the management of this department. 3500 w. Munic Af—Sept., 1897. No. 15955 C.

Subsurface Constructions.

A Lesson on the Necessity of Systematic Work in Subsurface Street Constructions. Editorial presenting facts regarding the Fifth avenue work in New York, and the lessons to be learned from them. 3200 w. Eng News—Oct. 21, 1897. No. 16089.

WATER SUPPLY.

Aeration.

Purifying Water by Aeration. Extracts from article by Dr. Heysinger, who believes that before many years aeration will be resorted to as the only means of purifying water. 1600 w. Fire & Water—Oct. 9, 1897. No. 15799.

Birmingham.

Birmingham Corporation Water Works. H. Davey. Abstract of paper read at recent meeting of the Inst. of Mech. Engs. in Birmingham, Eng. History of the undertaking, the present condition, reservoirs, &c. 3200 w. Jour Gas Lgt—Sept. 28, 1897. No. 15765 A.

Broken Main.

Serious Break in a Water Main An account of the damage caused by the breaking of a main at Madison avenue and Forty-second street, New York. Ill. 900 w. Fire & Water—Oct. 16, 1897. No. 15997.

Budapest.

The Water Supply of Budapest. (Alimentation d'Eau de Budapest.) Illustrated account of filter plant, pumping station, and reservoirs for the supply of the city of Budapest. 4000 w. 1 plate. Le Génie Civil—July 31, 1897. No. 15804 D.

Electrolysis.

Electrolysis and Water Mains in Salt Lake City, Utah. Summary of opinions regarding the indications and causes of electrolytic action and methods of determining the location as given in report of F. C. Kelsey, in a paper read before the Denver Convention of the American Water-Works Assn. 5000 w. Eng Rec—Oct. 16, 1897. No. 16057.

Epidemic.

The Maidstone Epidemic. Editorial on the impure water supply that has caused the serious epidemic of typhoid in this district of England. 1000 w. Engr, Lond—Oct. 1, 1897. No. 15920 A.

Filtration.

Another Court Decision Regarding the Use of a Coagulant in Mechanical Filters. Decision rendered in the United States by Judge Coxe regarding the use of alum or other coagulants in mechanical filters being an infringement of the Hyatt patent. 1200 w. Eng. News—Sept. 30, 1897. No. 15661.

Bacterial Test of Mechanical Filters at Lorain, O. Taken from the *Ohio Sanitary Bulletin.* Valuable information regarding the bacterial efficiency of mechanical filtration, with editorial comment. 5800 w. Eng News—Oct. 28, 1897. No. 16208.

The Filtration of Water. Edmund B. Weston. Read before the National Convention of Mayors and Councilmen, at Columbus, O. Discusses and describes the purification of water by sand filtration, and by mechanical filtration aided by the application of chemicals. 4800 w. Munic Engng—Oct., 1897. No. 15729 C.

Fire Supplies.

Rules for the Use of Private Fire Supplies Providence Water-Works. Reprinted from the official rules issued by Robert E. Smith, Commissioner of Public Works. 900 w. Eng News—Oct. 28, 1897. No. 16209.

Forest Denudation.

Effect of Forest Denudation on Water Courses and Water Supply. Daniel W. Baird. Abstract of a paper presented at the annual convention of the American Forestry Assn., at Nashville, Tenn. Notes the fact that the water-level of certain districts has fallen many feet, and shows that if forest growths do not increase the rainfall, they help retain what does fall. 1100 w. Eng News—Oct. 21, 1897. No. 16083.

Jersey City, N. J.

The Latest Jersey City Water-Supply Specifications. Outline of the specifications, prepared from information furnished by C. C. Vermeule. 450 w. Eng News—Sept 30, 1897. No. 15664.

Pipe Joints.

The Packing of Terra Cotta Pipes. (Ueber das Dichten von Steingutröhren.) Describing improved methods of making tight bell joints with terra cotta drain pipe with especial reference to the use of asphalt. 4000 w. Gesundheits Ingenieur—August 31, 1897. No. 15838 B.

Pipes.

The Practical Computation of the Resistances in Pipes. (Ein Beitrag zur Berechnung des Rohrwiderstandes in der Praxis.) With particular reference to the flow of water in cast iron pipe; friction due to incrustation, influence of slope, &c. 6000 w. Gesundheits Ingenieur—September 15, 1897. No. 15839 B.

Pumping Engine.

Test of a 30,000,000 Gallon Pumping Engine at Buffalo, N. Y. Description, with front elevation, of the vertical triple-expansion pumping-engine, built for the Buffalo City Water Works, and report of the high duty obtained on the official test. 1200 w. Eng News—Sept. 30, 1897. No. 15657.

The D'Auria Pumping Engine. Illustrated description of an engine which is a development in the direct-acting duplex type, and report of tests. 1100 w. Engng—Oct. 8, 1897. No. 16038 A.

The William Radcliffe Pumping Engine, Aubrey-Street, Liverpool. Alfred Towler. Read before the British Assn. of Waterworks Engineers. Illustrated description of an up-to-date pumping engine, with a summary of results of the official duty trial. 4700 w. Engr, Lond—Oct 15, 1897. No. 16140 A.

Triple-Expansion Vertical High-Duty Worthington Pumping-Engine. Report of two trials recently carried out by W. C. Unwin, at Hampton Pumping Station for the West Middlesex Waterworks. Gives general description of the engines. Ill. 5500 w. Engr, Lond—Sept. 24, 1897. No. 15690 A.

Pumping Station.

Chestnut Hill Pumping Station, Boston. Illustrated description. 3500 w. Fire & Water—Oct. 16, 1897. No. 15996.

Reservoir.

The Wolfsgraben Reservoir and the High Water of July 30, 1897. (Das Wolfsgraben-Reservoir und das Hochwasser vom 30 July, 1897.) An interesting account of the relief of the reservoir of the Vienna water supply during heavy flood. With photographs of the overflow canal taken at close intervals of time. 3500 w. Oesterr Monatschr f d Oeffent Baudienst—Oct., 1897. No. 16197 D.

Reservoir Accident.

Accident to a Concrete-Covered Reservoir at Wellesley, Mass., While Under Construction. Illustrated account of the falling of a portion of the roof of a concrete-covered reservoir. 450 w. Eng News—Sept. 30, 1897. No. 15663.

Sterilization.

Sterilization of Impure Water by Ozone. E. Andreoli. Reports favorable to the use of ozone for this purpose, and recommends that its efficiency be tried in small towns and villages. 1500 w. Elec Rev, Lond—Oct. 15, 1897. No. 16123 A.

Syracuse.

Syracuse, N. Y., Water-Works. William R. Hill. Historical account, with description, cost, rates, consumption, &c. Ill. 3300 w. Fire & Water—Oct. 2, 1897. No. 15731.

Typhoid Fever.

The Effect of a Pure Water Supply on Typhoid Fever in Newark and Jersey City, New Jersey. Report of the remarkable decrease following the change to pure water, with interesting particulars. 2000 w. Eng News—Sept. 30, 1897. No. 15659.

Water Mains.

Are the Water Mains in Danger? Discusses the difficulties from the laying of underground electric trolley tracks on Amsterdam avenue, New York. 900 w. Fire & Water—Oct. 23, 1897. No. 16119.

Machines for Inserting Valves and Branches in Water Mains under Pressure. A brief illustrated description of the devices and methods of operating them. 1300 w. Eng News—Oct. 28, 1897. No. 16212.

Water-Tower.

The Water Tower at Nijni-Novgorod. (Le Chateau-d'Eau de Nijni-Novgorod.) The tower is made of straight bars of iron in the form of a hyperboloid of revolution, giving great strength and extreme simplicity of construction, all members being alike. An ingenious and effective idea. 1000 w. Le Génie Moderne—Sept. 15, 1897. No. 15834 B.

Water-Works.

The Financial Management of Water-Works. E. Kuichling. Condensed from annual report of the Executive Board of the city of Rochester, N. Y. Discussion of how the works may be conducted on business principles. 3800 w. Munic Engng—Oct., 1897. No. 15730 C.

Williamsport, Pa.

Water Supply of Williamsport. Comments on the exceptional purity of the supply and the care necessary to keep it so, with other information. 1000 w. Fire & Water—Oct. 23, 1897. No. 16120.

MISCELLANY.

Address.

Professor Ramsay's Address before the British Association, at Montreal. Abstract of the address on the "undiscovered gas" whose place lies between argon and helium. 1700 w. Engng—Oct. 8, 1897. No. 16036 A.

City Noises.

To Abate the Plague of City Noises. John H. Girdner. Presents the effect of unnecessary noise on the public health and comfort, and offers suggestions for lessening the disturbance. 3000 w. N Am Rev—Oct., 1897. No. 15725 D.

Consulting Engineers.

Are Consulting Engineers a Necessity or a Luxury? The duties of consultants, their qualifications, power, &c., are considered, with opinion as to when they are necessary, and when a luxury. 1800 w. Elec, Lond—Sept. 24, 1897. No. 15711 A.

The Consulting Engineer in Municipal Affairs. William H. Searles. Shows the necessity of an engineering department of a great city, the growth of the work as the city increases in size, and the advisability of employing a consulting engineer that the work may be properly carried on. 3000 w. Jour Assn of Eng Soc—Sept., 1897. No. 15992 C.

Garbage.

The Disposal of Garbage and Refuse. Rudolph Hering. Gives information of the construction, cost, and operation of the Hamburg, Germany, works, with illustrations. 4500 w. Eng Rec—Oct. 23, 1897. No. 16128.

The Sanitary Disposal of Garbage. Abstract of discussion taken from Proceedings of the Massachusetts Assn. of Boards of Health. Discusses the feeding garbage to stock, burying, cremation, reduction, &c. 6500 w. San—Oct., 1897. No. 15744 D.

Public Works.

The Management of Public Works in Greater New York. Reports concerning the provisions of the new charter for the administration of the public works of this great municipality. 4500 w. Eng Rec—Oct. 30, 1897. No. 16248.

Report.

Report of the Committee on Photometry of the German Gas and Water Works Association. (Bericht über die Arbeiten der Lichtmess-Kommission des Deutschen Vereins von Gas-und Wasser fachmännern.) A review of the bulky report of this important committee dealing with the subject of photometric units and methods, and the comparison of various illuminants. 1200 w. Gesundheits Ingenieur—August 31, 1897. No. 16355 B.

Roads.

The New Road-Law of Montana. M. S. Parker. Discusses the recently enacted law, making county surveyors general superintendents of all roads in their counties. 2000 w. Jour Assn of Eng Soc—Sept., 1897. No. 15991 C.

Smoke Prevention.

Progress in the Matter of Smoke Abatement. (Fortschritte auf dem Wege zur Russbeseitigung.) With especial reference to the devices recently tried in Berlin and Dresden. 2500 w. Gesundheits-Ingenieur—August 31, 1897. No. 15837 B.

Street Lighting.

Chaotic Condition of Our Street-Lighting System as to Cost, etc. D. Hunter. Read before the National Street-Lighting Assn., Columbus, O. Statistics of cost in a number of cities in various States are given and comparison made. 1300 w. Elec Eng, N Y—Oct. 7, 1897. No. 15756.

Street Lighting by Contract and by Municipal Ownership. John McVicar. Abstract of a paper read before the Mayor's Convention, Columbus, Ohio. Consists mostly of an account of experience in Des Moines, Ia. 1400 w. Elec Eng, N Y—Oct 7, 1897. No. 15755.

Street Railways.

See Street and Electric Railways.

RAILROAD AFFAIRS.

NEW CONSTRUCTION.

China.

The Eastern Railway of China. (Le Chemin de Fer de l'Est de la Chine.) Discussing the Chinese railway in connection with the Siberian system and the gold deposits in Manchuria, with topographical map of existing and proposed lines. 3500 w. Le Génie Civil—September 11, 1897. No. 15815 D.

Improvements.

Monon Improvements. An illustrated account of the work of eliminating curves and grades near Cedar Lake, Indiana. 1000 w. Ry Age—Oct. 22, 1897. No. 16151.

Indian Railways.

A Remarkable Indian Railway. Interesting account of the Mushkaf-Bolan Railway in Baluchistan. 2700 w. Trans—Oct. 8, 1897. No. 16069 A.

Jungfrau.

The Jungfrau Railway. L. Bayly. Interesting illustrated description of this great engineering work. 1800 w. Engr, Lond—Oct. 1, 1897. No, 15919 A.

Santo Domingo.

The Central Dominican Railway. Brief description of the second line of railway to be built in this republic, which was recently opened for traffic. 800 w. Eng News—Oct. 21, 1897. No. 16085.

MAINTENANCE OF EQUIPMENT.

Air Braking.

Modern Compressors for Air-Braking. E. J. Wessels. Illustrated description of a compressor of the single-acting type, with double cylinders which are placed vertically, with trunk pistons connecting directly to eccentrics in crank case. 1200 w. Elec Rev, N Y—Oct. 20, 1897. No. 16047.

Box Cars.

New Box Cars for the Big Four. Description, with engravings of details, of the 1000 box cars which Pullman's Palace Car Co. has lately built for the Cleveland, Cincinnati, Chicago & St. Louis R. R. 1200 w. R R Gaz—Oct. 29, 1897. No. 16216.

Brakes.

Experiments Upon Auxiliary Reservoirs. G. R. Henderson. Graphical representation of the effects of varying the capacity of the auxiliary reservoir for a given size of brake-cylinder, with explanation. 800 w. Am Eng & R R Jour—Oct., 1897. No. 15652 C.

Brake Shoe.

A New Brake-Shoe. Illustrated description of shoe called the "Diamond S." offered by the Sargent Company of Chicago. It consists of a bundle of expanded metal sheets of steel about which molten iron is cast. 1400 w. Ry Mas Mech—Oct., 1897. No. 15665.

Car Construction.

Malleable Iron in Car Construction and Repairs. Eugene Chamberlin. Read before the Central Railway Club. Facts with relation to the benefits obtained from its general use. 1500 w. Pro of Cent Ry Club—Sept., 1897. No. 15750 D.

Car Lighting.

The Lighting of Cars by Electricity. (L'Eclairage Electrique des Wagons.) A very full review of experience and practice in France, Switzerland, Italy and Germany, with details of arrangement and data of cost. Three articles. 7000 w. Le Génie Civil—July 31, August 7 & 14, 1897. No. 15805 H.

Freight Cars.

New Freight Cars for the Mexican Central. An order for about one thousand cars, including box, coal, and stock cars is being filled for this road, and the engravings and description show the construction in detail. 1100 w. R R Gaz—Oct. 8, 1897. No. 15776.

Locomotive Car.

Locomotive Car on the New England Railroad. Describes a combination car and locomotive, giving illustration of the locomotive. 800 w. Ry Rev—Oct. 16, 1897. No. 16062.

Locomotives.

American Express Locomotives. Angus Sinclair. Extract from article in *Pall Mall Magazine*. Remarks on the changes that follow railroad construction, the early locomotives, the progress and the claim of American locomotives of being less complicated than others. 1800 w. Loc Engng—Oct., 1897. No. 15649 C.

Express Locomotive for the Midland Railway, England. Two page engraving, with other views, description and dimensions of the most recent type of express-passenger engine, designed by S. W. Johnson for service of fast trains on this line. 1500 w. Engng—Oct. 15, 1897. No. 16125 A.

New Locomotives on the Chicago, Rock Island & Pacific Railway. A half tone illustration of one of the passenger engines, with dimensions. 400 w. Ry Rev—Oct. 16, 1897. No. 16065.

North-Eastern Engines and Their Work. Charles Rous-Martin. A record of the work that has been done by these English engines, under the personal observation of the writer. Proves them to be highly satisfactory. 3000 w. Engr, Lond—Sept. 24, 1897. No. 15687 A.

Passenger Locomotive, Great Western Railway. Illustration and general dimensions. 200 w. Engr, Lond—Oct. 8, 1897. No. 16028 A.

Special Mountain Freight Engine for the Mexican Central Railway. Illustrated description of the largest engine made at the Brooks Locomotive Works, with its interesting features. 2000 w. R R Gaz—Oct. 29, 1897. No. 16215.

Ten-Wheel Freight Engine, Chicago &

Northwestern Railway. Illustration, dimensions and other particulars. 750 w. R R Gaz—Oct. 29, 1897. No. 16219.

Ten-Wheel Passenger Locomotive—Atchison, Topeka & Santa Fe. Illustrated detailed description with general dimensions. 1200 w. R R Gaz—Oct. 22, 1897. No. 16092.

The Hagens Coupled Locomotive. Description, with illustration, of a 70-ton engine with four coupled axles, for steep gradients and sharp curves. The chief dimensions are given. 600 w. Engng—Oct. 8, 1897. No. 16039 A.

Von Borries Four-Cylinder Compound Locomotive. Translated from an article by Herr Von Borries in *Glaser's Annalen*. A general description with comparison of the new locomotives with those previously built, stating the advantages. Also editorial. 3000 w. Am Eng & R R Jour—Oct., 1897. No. 15663 C.

Various Locomotive Cylinders. Clement E. Stretton. Consideration of locomotives with one, two, three and four cylinders. 1300 w. Mech Wld—Oct. 15, 1897. No. 16122 A.

Lubrication.

See Mechanical Engineering, Miscellany.

Painting.

Is it Advisable to Rub to a Dead Finish the Interior of Passenger Cars? What is the Extra Cost? Papers by Robert McKeon, R. G. Barinowski and C. A. Bruyere read at meeting of the American Master Car and Locomotive Painters' Assn., with discussion. 6000 w. R R Car Jour—Oct., 1897. No. 15673.

Painting Railway Equipment with Compressed Air. Papers by Messrs. McMasters, Kahler and Copp, read before the American Master Car and Locomotive Painters' Assn., with discussion. 9000 w. R R Car Jour—Oct., 1897. No. 15670.

Private Car.

President McKinley's Inauguration Car. Illustrated description of the car used to convey President McKinley from Canton, Ohio, to Washington to be inaugurated. 500 w. Ry Mag—Aug., 1897. No. 15676 C.

Protective Paint.

Protective Paint for Metal Parts of Cars and Trucks. Papers by J. H. Pitard and A. Hunicke, read before the American Master Car and Locomotive Painters' Assn., with discussion. 6500 w. R R Car Jour—Oct., 1897. No. 15668.

Repairs.

See same title under Mechanical Engineering, Boilers, Furnaces and Firing.

Roller Bearings.

Comparative Test of Roller Bearings. Reports a test recently made by the Union Railroad Company, Providence, R. I., to determine the saving in power, if any, by the use of roller bearings for the car axles as compared with the solid bearings ordinarily in use. The saving was shown to be 13 per cent. of the whole power consumed. 800 w. Am Mach—Oct. 21, 1897. No. 16100.

Springs.

Helical versus Elliptical Driving-Springs. Edward Grafstrom. Describes a trial of helical springs made at the writer's suggestion and gives the favorable results of the experiment. 2000 w. R R Gaz—Oct. 1, 1897. No. 15682.

Surfacing.

What Methods of Surfacing Will Give Fairly Good Results Without the Use of Either Sandpaper or Lump Pumice-stone for Passenger Cars or Locomotive Tenders. Papers by C. E. Koons and C. A. Cook read before the American Master Car and Locomotive Painters' Assn., with discussion. 5500 w. R R Car Jour—Oct., 1897. No. 15669.

MAINTENANCE OF WAY.

Bridge Floors.

Bridge Floors. Report of committee on open floors for railway bridges. Illustrations of different types are given. 3200 w. American Assn of Ry Supts of Bridges and Buildings. No. 15947 D.

Bridge Warnings.

Bridge Warnings for Low Overhead Structures. Committee report on the systems in use, mentioning the important characteristics and practical features, and an appendix containing descriptions and illustrations of a large variety of bridge warnings. 4000 w. American Assn of Ry Supts of Bridges & Buildings. No. 15946 D.

Gage.

Should the Gage of Railway Track be Widened on Curves? Abstract of replies received to questions bearing on this subject, sent out by the committee of the American Railway Assn. 4000 w. Eng News—Oct. 14, 1897. No. 15974.

Ice-Houses.

Designs for Ice-Houses. Report of committee, discussing the quantity of ice, how obtained and delivered, and general requirements, with opinions on manufactured ice; also the designs of ice-houses with plans of two storage houses. 6500 w. American Assn of Ry Supts of Bridges and Buildings. No. 15945 D.

Lateral Pressure.

The Lateral Pressure upon Rails due to the Rotation of the Earth. (Die Seitliche Verschiebung der Eisenbahnschienen in Folge der Achsendrehung der Erde.) A mathematical analysis by Dr. Koller, showing that the pressure due to the rotation of the earth is so slight as to be negligible. 2500 w. Glaser's Annalen —September 15, 1897. No. 16188 D.

Rails.

New 100-lb. Rail and Splice Bars for the Illinois Central R R. Section, dimensions and brief description. 300 w. Eng News—Oct. 21, 1897. No. 16088.

Replacing Bridge.

Replacing Bridge No. 69, Pennsylvania R R., near Girard Ave., Philadelphia. Jos. Wood Wagner. Description, with illustration, of the replacing of a Whipple-truss bridge, with a Pratt truss, the work consisting of the bodily removal of the old and substitution of the new span, so as not to interrupt the traffic between Philadelphia and New York. 2000 w. Eng News—Oct. 21, 1897. No. 16082.

Station.

New Union Station at Columbus, O. Description, with illustration, plan and sections of a very elaborate railway building recently completed. 1300 w. Ry Rev—Oct. 16, 1897. No. 16063.

The Providence, R. I., Station of the New York, New Haven, and Hartford. Calling attention to special points in these new railroad-station buildings. Ill. 900 w. R R Gaz—Oct. 1, 1897. No. 15681.

St. Lawrence Bridge.

See Civil Engineering, Bridges.

Stock-Yards.

Stock-Yards and Stock-Sheds, Including All Details of Construction. Numerous plans showing the practice of different railways, with brief report of committee. 1200 w. American Assn of Ry Supts of Bridges and Buildings. No. 15948 D.

Swing Bridge.

See Civil Engineering, Bridges.

Switchback.

The Cascade Switchback and Tunnel of the Great Northern. Map and profile of the tunnel and switchback, with account of the manner of handling the trains over the switchback, the distance saved by the tunnel, and other matters of interest. 700 w. R R Gaz—Oct. 15, 1897. No. 15960.

Ties.

Average Life of Cross-Ties in Steam Railroads in Colorado. William Ashton. Reports concerning ties used in Colorado, and the life of the different kinds used, with remarks on metallic ties. 1200 w. Jour Assn of Eng Soc—Sept., 1897. No. 15993 C.

Tie Preserving. S. M. R. Letter to the editor containing facts from the experience of the writer as to the value of tie preserving. 1000 w. Ry Rev—Oct. 9, 1897. No. 15937.

Track Elevation.

Progress of Track Elevation by the Chicago & Northwestern Railway in Chicago. An account of rapid work. 1000 w. Eng News—Oct. 28, 1897. No. 16214.

Tracks.

Wood Screws and Spikes for Railroad Track Use. A. Morrison. Considers the movements of the several parts comprising the track that affect the spike or screw, and the relative merits of wood-screws and spikes in holding the rail and cross-tie together. 1600 w. R R Gaz—Oct. 15, 1897. No. 15961.

Waterways.

How to Determine Size and Capacity of Openings for Waterways. Committee report of methods actually adopted on railroads to obtain quick and practical results. 8800 w. American Assn of Ry Supts of Bridges & Buildings. No. 15944 D.

SIGNALING.

Automatic.

The Arrangement of Signals with Electrical Release for Operation by the Train. (Einrichtung von Mastsignalen mit Elektrischer Auslösung durch die Züge.) Description and details of the system by which the block signal is automatically set for "clear track" when the train leaves the block. 5000 w. Oesterr Monatschr f d Oeffent Baudienst—Oct., 1897. No. 16199 D.

Caution Signal.

The Caution Signal in the Proposed West Arlington Signaling. C. C. Anthony. Letter to the editor criticising the use of the caution signal in the scheme proposed for the West Arlington draw-bridge, and showing why it is objectionable. 2400 w. R R Gaz—Oct. 8, 1897. No. 15775.

Interlocking.

Definitions of and Regulations for the Use of Interlocking Switches and Signals. A reprint of the additions adopted by the American Railway Assn., Oct. 6, 1897. 1800 w. R R Gaz—Oct. 15, 1897. No. 15964.

Pflasterer's Combined Switch and Distant-Signal Movement. Illustrated description of a recent patent. The parts are operated by a single lever, which is thrown one way to set the signal and open the switch, and in the opposite direction to close the switch and clear the signal. 1200 w. R R Gaz—Oct. 15, 1897. No. 15962.

Rules for the Operation and Maintenance of Interlocking Plants. A copy of the rules for operation and maintenance, recommended by the Railway Signaling Club. 2500 w. R R Gaz—Oct. 15, 1897. No. 15965.

Signals.

See same title under Mechanical Engineering, Compressed Air.

TERMINALS AND YARDS.

English Stations.

English Goods Stations and Railway Yards. Arch. R. Whitehead. An account of the growth of English goods stations both at terminals and elsewhere, with many illustrations of stations and yards of the principal railways. 4000 w. Engineering Magazine—Nov., 1897. No. 15596 B.

Paris.

The Work of the Western Railway of France in Paris. (Les Travaux Parisiéns de la Compagnie del'Ouest.) Giving an account of the local and terminal extensions in Paris for the handling of the traffic of the Exposition of 1900. 5000 w. Map and profile. Le Génie Moderne—Oct. 1, 1897. Serial, Part 1. No. 15835 B.

Two Harbors, Minn.

Two Harbors Terminal of the Duluth & Iron Range Railroad. Illustrated description of the dock yards and terminals; the design of the yard and approaches to the ore-docks are a fine example of railroad construction. 800 w. Ry Rev—Oct. 9, 1897. No. 15938.

TRANSPORTATION.

Accidents.

English Railroad Accidents in 1896. Facts taken from the general report made by Secretary Hopwood. 1500 w. R R Gaz—Oct. 15, 1897. No. 15966.

The New York Central and Hudson River R. R. Wreck Near Garrisons, N. Y. An account of the disaster which cost the lives of twenty-one persons, with editorial. 2000 w. Eng News—Oct. 28, 1897. No. 16210.

Train Accidents in the United States in August. Detailed list with classified summary. 3400 w. R R Gaz—Oct. 1, 1897. No. 15684.

Train Accidents in the United States in September. Detailed list, with classified summary and editorial. 5000 w. R R Gaz—Oct. 29, 1897. No. 16217.

Earnings.

September's Heavy Railroad Earnings. Reports railroad earnings in the United States even more satisfactory than in August. 3500 w. Bradstreet's—Oct. 16, 1897. No. 16000.

Long Run.

A Long Locomotive Run. Locomotive performance made between Evanston, Wyo., and Omaha, Neb., on the Union Pacific, Aug. 3, and 4, 1897. Official figures. 900 w. R R Gaz—Oct. 22, 1897. No. 16095.

Passes.

Pass-Selling in Illinois. Editorial on a bill passed by the Illinois Legislature to prevent buying, selling or fraudulently using passes. 600 w. Ry Age—Sept. 10, 1897. No. 15303.

Report.

Eleventh Annual Report of the Denver & Rio Grande R R. Summary of operations presented to the stockholders by E. T. Jeffrey, with editorial. 1500 w. Ry Rev—Oct. 23, 1897. No. 16158.

Tickets.

Kilometric Tickets and Ticket Money. (Carnets Kilometriques et Tickets-monnaie.) Discussing the question of mileage tickets and also the sale of reduced rate coupons in quantity for subsequent use in purchase of railway tickets. 1000 w. Le Génie Civil—September 4, 1897. No. 15813 D.

MISCELLANY.

Braking.

Train Acceleration and Braking. W. B. Potter. Presents fundamental formulæ and endeavors to show how far they are borne out by actual tests. 1600 w. St. Ry Jour—Oct., 1897. No. 16009 D.

Coal Handling.

Some Modern Methods of Loading Coal. Illustrated description of some of the systems in use. 2400 w. Ir & Coal Trs Rev—Oct. 8, 1897. Serial. 1st part. No. 16066 A.

Celebration.

Twenty five Years of Progress. An illustrated account of the celebration of the Atchison, Topeka & Santa Fé's quarter century of active life, with addresses by E. P. Ripley and Aldace F. Walker. Ill. 2800 w. Ry Age—Oct. 8, 1897. No. 15936.

Color-Vision.

Standards of Form and Color-Vision Required in Railroad Service. Charles H. Williams. A paper read at meeting of the American Ophthalmological Society, in Washington. Some information of the standards of vision required on different roads, with discussion of what should be required, and suggestions. 5500 w. R R Gaz—Oct. 8, 1897. No. 15777.

Combination.

The Grand Trunk System and the Central Vermont. An account of the terms on which the Grand Trunk Railway Company have received absolute control of the Central Vermont system, with brief history of the latter road. Map. 900 w. Ry Age—Oct 22, 1897. No. 16150.

English Railways.

Home Railways as Investments. A discussion of the indications that English railways as investments are coming again into favor. 3700 w. Trans—Oct. 1, 1897. No. 15923 A.

France.

The Administration of Six Great French Railway Systems. (Quelques Chiffres sur l'Exploitation des six Grand Reséaux Français.) A comparative study of financial management with diagrams and tabulated statements. 2500 w. 1 plate. La Revue Technique--Sept 10, 1897. No. 15879 D.

Heating.

See also Architecture and Building, Heating.

High Railroading.

The Highest Adhesive Railroad in Europe. Simon Linden. Describes and illustrates the Davos-Landquart-Thusis Railroad, which runs through a very mountainous part of eastern Switzerland. 600 w. Loc Engng--Oct., 1897. No. 15648 C.

Light Railways.

Light Railways. Editorial inquiry into the saving of expense alleged for this class of road, because of lesser cost of construction. 1800 w. Engr, Lond--Oct. 8, 1897. No. 16030 A.

Management.

Colonial Railway Management. Commendatory of the Australian railways, giving results as taken from the annual report of 1896-7. 1500 w. Trans--Oct. 8, 1897. No. 16070 A.

Motive Power.

Application of Electricity to Railroads Now Operated by Steam Power. N. H. Heft. Abstract of paper read at convention of the American Street Railway Assn. Reviews the work of the New York, New Haven and Hartford Railroad Company in heavy electric railroading, giving the results. 3800 w. Elec Wld—Oct. 23, 1897. No. 16165.

Electric Motive Power. W. H. Weston. Thinks it a mistake to use it in any extended way for motive power purposes. 2400 w. Ry Mag—Sept., 1897. No 16159 C.

Prices.

How Can the Elementary Rate-Fixing Be Best Attained for Use in Establishing Piece-Work Prices in the Railway Paint-Shop? Papers by Messrs. Ball and Lanfersiek read before the American Master Car and Locomotive Painters' Assn. 2400 w. R R Car Jour—Oct., 1897. No. 15671.

Railroads.

"Railroads—the World's Greatest Benefactors." W. S. Glover. On the civilizing and educating influence of railroads. 3300 w. Ry Mag—Aug., 1897. No. 15675 C.

The People and the Railroads. J. B. Flemming. Argument before the Georgia railroad commission which clearly sets forth the relations of the railroads, the people, and the state. 1500 w. Mfrs Rec—Oct. 1, 1897. No. 15646.

Railroad Relics.

The Field Columbian Museum and Railroad History. Herbert T. Walker. Information of this collection of relics, models, photographs and drawings, in Chicago, illustrating the development of transportation and motive power from the year 1680 to the present time. 1100 w. R R Gaz—Oct. 22, 1897. No. 16094.

Statistics.

Statistics of Railways in the United States for the year ending June 30, 1896. Figures from the advance abstract of the ninth annual statistical report of the Commission. 1400 w. Eng News—Oct. 21, 1897. No. 16091.

U. S. Railways.

The Railroads of the United States. Reasons why American railroad shares do not readily find a market ln England, with review of results for the last three years as given in "Poor's Manual." 1500 w. Trans—Sept. 24, 1897. No. 15708 A.

Ventilation.

The Ventilation of the Metropolitan Railway. Editorial on the "Blue-book" just issued by the Board of Trade Committee appointed to report on the London underground railway, as to the quality of the air, and the remedy. 2000 w. Engr, Lond—Oct. 15, 1897. No. 16138 A.

STREET AND ELECTRIC RAILWAYS.

Accidents.

A Chapter of Accidents. William J. Clark. Calls attention to the exaggeration of street-railway accidents, and presents statistics bearing upon the matter, aiming to state the facts exactly as they are. 2800 w. St Ry Jour—Oct., 1897. No. 16008 D.

The Best Method of Settling Damage Cases and the Prevention of Accidents by the Use of Fenders or Otherwise. Willard J. Hield. Read before the American Street Railway Assn. Discussion of the subjects, considering points of particular interest. 1400 w. Elec Eng, N. Y—Oct. 21, 1897. No. 16170.

Air Braking.

See also Railroad Affairs, Maintenance of Equipment.

Binghamton, N. Y.

The Binghamton, N. Y., Electric Railroad. Harry N. Gardner. Illustrated detailed description. 2000 w. Elec Eng, N. Y—Oct. 14, 1897. No. 16045.

Braking.

Recent Tests of Acceleration and Braking. Report of tests made by the engineers of the American General Electric Co. to find out the maximum rate of acceleration that could be imparted to a car without discomfort to the passengers. Also a consideration of rapid braking. 1800 w. Eng News—Oct. 14, 1897. No. 15973.

Cable Line.

Cable Line Operated by Electric Motor. Charles Grover. Describes and illustrates the motor-driven cable-plant at Kansas City, Mo., and shows the economy resulting from change of power from steam to electricity. 1200 w. St Ry Rev—Oct. 15, 1897. No. 15986 C.

Chicago Elevated.

Elevated Railway Progress in Chicago. Reports the use of the Union Loop since Oct. 3 by one road, and the preparations of other roads to soon use it. Gives also information relating to the loop. Ill. 1300 w. W Elect'n—Oct. 9, 1897. No. 15939.

Raising the Metropolitan West-Side Elevated Railway of Chicago. Illustrated description of work made necessary by the elimination of railway crossings at grade, along Rockwell street, where the elevated road crosses the tracks of two surface roads. 2500 w. Eng News—Sept. 30, 1897. No. 15656.

Distribution.

Distribution of Street-Railway Mileage and Capitalization in America. Tables of interesting statistics with remarks on the great expansion in mileage and capital investment since 1880. 1500 w. St Ry Jour—Oct., 1897. No. 16007 D.

Dover, England.

Dover Municipal Electric Tramways. Illustrated detailed description. 5500 w. Ry Wld—Oct., 1897. No. 15995 A.

Dynagraph.

A Dynagraph Car for Street Railways. Illustrated description of the principal features of a dynagraph car for recording defects in street-railway track, which has been in successful use in Chicago. 1300 w. Eng News—Oct. 14, 1897. No. 15972.

Economy.

Economy in Electric Car Control. J. R. Cravath. Read before the Chicago Electrical Assn. Discusses the economy possible by correctly handling the controller, and the need of records being kept that will serve as an incentive to motormen to give attention to the matter. 4000 w. W Elect'n—Oct. 9, 1897. No. 15941.

Electrolysis.

The Latest Method of Electrolysis Prevention. Harold P. Brown. A comparison of European and American requirements, brief explanation of the cause of electrolysis, describing a method of prevention designed by the writer. Ill. 2200 w. Elec Eng, N. Y—Oct. 14, 1897. No. 16046.

Engines.

Engines for Electric-Railway Power-Stations. Charles E. Emery. Some remarks on the general subject of engine building, with description of a number of the more prominent steam engines for operating electric-railway generators. Ill. 16000 w. St Ry Jour—Oct., 1897. Serial. 1st part. No. 16005 D.

European Practice.

Street Railway Engineering in Europe. G. H. B. Zahn. Part first consists of general remarks with a brief description of the system in Zurich, Switzerland. 700 w. Elec Eng, N Y—Oct. 7, 1897. Serial. 1st part. No. 15753.

High Speed.

A High-Speed Road—The Lorain and Cleveland Electric Railway. E. P. Roberts. Illustrated detailed description of a completely equipped and thoroughly constructed American line. 2700 w. Elec Eng, N Y—Oct. 14, 1897. No. 16044.

Minneapolis.

The Construction of Street Railway Tracks in Minneapolis and St. Paul, Minnesota. F. W. Cappelen. Paper presented at the Chicago meeting of the American Society of Municipal Improvements, with views. A very full account of this work. 2500 w. Eng News—Oct. 14, 1897. No. 15971.

Motive Power.

Electricity as a Motive Power for the Suburban-Railway Service of New England. Sidney H. Short. Considers the suburban service about Boston as representative of that of all the territory under discussion. Shows the operating expenses to be largely in favor of electricity. 3500 w. St Ry Jour—Oct., 1897. No. 16010 D.

The Battle of the Motive Powers. Editorial presenting a brief résumé of the relative advantages and disadvantages of different forms of motive power so far as developed in actual practice up to the present time. 4000 w. St Ry Jour—Oct. 1897. No. 16006 D.

Power Distribution and the Use of Multiphase-Current Transmission for Ordinary Street Railways. Maurice Hoopes. Read at the Convention of the American Street Railway Assn. The paper considers the comparative merits of systems to meet the demands of changed conditions brought about by extensions of roads and other causes. 7000 w. Elec Wld—Oct. 23, 1897. No. 16163.

Motors.

Railway-Motor Design. Alfred E. Wiener. States the conditions desirable in a railway motor, considering each separately. Also gives calculations connected with railway motor design. 2500 w. Am Elect'n—Oct., 1897. No. 15972.

Motor Testing.

Some Methods of Making Efficiency Tests of Street-Railway Motors. Frank B. Porter. Describes a simple method of efficiency test which will give good results when applied to the street-railway motor in the repair shop. Ill. 1800 w. St Ry Rev—Oct. 15, 1897. No. 15988 C.

Municipal Ownership.

A Matter of Municipal Ownership, and What Came of It. F. M. Explains the position of the city of New York in its relation to the Sixth and Eighth Avenue systems. 2000 w. Harper's Wk—Oct. 30, 1897. No. 16172.

Municipal Ownership.

Municipal Ownership and the Operation of Street Railways. P. F. Sullivan. Abstract of a paper read before the convention of the American Street Railway Assn. Unfavorable to municipal ownership in American cities. 800 w. Elec Wld—Oct. 23, 1897. No. 16166.

Niagara Falls.

Street Railways of Niagara. Brief illustrated descriptions of the various electric lines on both sides the river, covering 127 miles of track. 4400 w. St Ry Rev—Oct. 15, 1897. No. 15983 C.

The Electric Railways of the Niagara River Region. A brief review of the conditions which have affected the industrial growth of this region, the street railway development, and other things of interest. Ill. 11500 w. St Ry Jour—Oct., 1897. No. 16004 D.

One Rail.

A One-Rail System of Light Railway. Fred. J. Rowan. Abstract of a paper read before the Federated Inst. of Mining Engs. Presents the advantages of the system under consideration. 1600 w. Col Guard—Sept. 24, 1897. No. 15699 A.

Portable Railways.

Portable Electric Railways. Extracts from paper by F. Zezula, in the *Zeitschrift für Kleinbahnen*, discussing the value of light portable railways, with especial reference to military operations; and also from a paper by Dr. Werther, read before the German Brick Mfrs. Assn. on the use of electricity as a motive power on portable railways in brick works, &c. Ill. 1500 w. Brick—Oct., 1897. No. 15780.

Power Station.

The New 70,000 H. P. Central Power-Station of the Metropolitan Street Railway Company, New York. Brief illustrated description of the proposed structure. 1100 w. Elec Eng, N Y—Oct. 7, 1897. No. 15752.

Public Operation.

Public and Private Operation of Street Railways. I. Should Greater New York Operate Its Street Railways? Yes. John Dewitt Warner. II. Municipal and Private Ownership of Street Railways—A Study of Results and Possibilities. Edward E. Higgins. Two papers discussing the pros and cons of this subject. Munic Af—Sept., 1897. No. 15953 C.

Rapid Transit.

The Enormous Possibilities of Rapid Electric Travel. Charles Henry Davis and F. Stuart Williamson. With full detailed estimate of cost for the construction of a three-track electric railway between New York and Philadelphia capable of making the run in 36 minutes. Figures are given showing the probable expenses, receipts and profits. 4500 w. Engineering Magazine—Nov., 1897. No. 15592 B.

Storage Battery.

Application of the Storage Battery to Electric Traction. Charles Hewett. Extracts from a paper read at the American Street Railway Assn. Reviews the most important applications of the storage battery to electric traction. 2800 w. Elec Wld—Oct. 23, 1897. No. 16164.

Surface Contact.

Surface-Contact Street-Railway System. Illustrated description of experiments carried on at Schenectady, N. Y., upon a stretch of track forming a part of the tramway system of the General Electric Co.'s Works. 1600 w, Ir Age—Oct. 21, 1897. No. 16074.

Suburban.

Electric Traction for the Pennsylvania Railroad Company's Suburban Service near Philadelphia. Charles T. Child. Discusses the engineering side of the problem of adopting electric means for this suburban system. Ill. 3500 w. Elec Wld—Oct. 16, 1897. No. 16049.

Switzerland.

The Orbe and Chavornay Electric Railway. C. S. DuRiche Preller. Describes the line, power, rolling stock, electrical equipment, service, &c., giving net results of this road. 1600 w. Engng—Oct. 1, 1897. No. 15913 A.

Test Car.

New Electrical Features on the Lindell Railway, St. Louis. Describes a car for testing and maintaining bonding and other uses, designed by Samuel Barnes. 1000 w. St Ry Rev—Oct. 15, 1897. No. 15987 C.

Track Bonding.

Track Bonding—How Can We Obtain the Best Results? H. C. Newton. Discussion of the subject with the conclusion that the really practical process is to solder the bond to the rail. 1200 w. Elec, N. Y.—Sept. 29, 1897. No. 15672.

Tracks.

Girder Rails for English Street-Railway Tracks. Illustrated description of rail, with the reasons for using this type as given by Joseph Kincaid, the engineer. 800 w. Eng News—Oct. 14, 1897. No. 15969.

Track Renewal.

Track Renewal on the Olive Street Cable Road, St. Louis. An account of this work, which consists of laying 60-ft. rails with welded joints. 1000 w. R R Gaz—Oct. 22, 1897. No. 16093.

Trucks.

Peckham's Swivel-Trucks for High-Speed Electric Service. Illustrated description of trucks designed for high speeds and heavy loads. 800 w. R R Gaz—Oct. 15, 1897. No. 15963.

Vienna.

The Rolling Stock of the Vienna City Railway. (Die Fahrbetriebsmittel der Wiener Stadtbahn.) Describing and illustrating the locomotives and cars for the new local railway in the city of Vienna. Two articles. 1 plate. 7500 w. Zeitschr d Oesterr Ing u Arch Ver—September 17 and 24, 1897. No. 15829 E.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

The Q. & C. Company, Chicago, Ill., and New York.=Illustrated catalogue of cold-sawing machines, for hand and power operation in various situations and on various classes of work. Contains, also, matter descriptive of sawing-machine grinders and their use.

Frank Kneeland Machine Co., Pittsburg, Pa., U. S. A.=Handsomely illustrated catalogue of rolling-mill machinery, roll-turning lathes, shears of various types, roll-trams, cold-rolling, structural and bar mills, blooming mills, hydraulic cranes, etc. The half-tone engravings, which are excellent, are accompanied by very brief descriptive text.

The Stirling Metal Co., Stirling, New Jersey, U. S. A.=Small circular describing the Stirling anti-friction metal, Babbitt metal, and white brass.

Stedman's foundry and machine works, Aurora, Ind., U. S. A.=(*a*) illustrated descriptive catalogue of crushing, grinding, pulverizing, mixing, and screening machinery, devoted chiefly to Stedman's disintegrator for ores, rock, clay, fertilizers, and other materials. Engravings and sectional drawings show the machinery in various sizes, with data of weight, capacity, power, and price; (*b*) special catalogue of the machinery as adapted to handling clay, shale, and slate for paving-brick, pottery, tiling, etc.; (*c*) pamphlet illustrating and describing coal-breaking, coke-crushing, and pulverizing machinery; (*d*) special circular of machinery adapted to grinding aud screening lime, gypsum, soap-powder, white lead, and similar materials.

Landis Tool Co., Waynesboro, Pa., U. S. A.=Illustrated descriptive catalogue of universal and plain grinding machines for cylindrical, conical, and plane-face surfaces. The photo engraving of each machine is accompanied by general data of capacity, power, speed, weight, accessories, etc.,—and complete general description and list of sizes is appended.

Harrison Safety Boiler Works, Phila., Pa., U. S. A.=Leaflet of the "Cochrane Special Feed-Water Heater and Receiver," with diagram showing the pipe connections.

Geo. F. Molter & Sons, York, Pa., U. S. A.=Leaflet with illustration and table of principal dimensions of the "Molter" portable engines.

Queen City Supply Co., Cincinnati, Ohio., U. S. A.=Small illustrated catalogue of vises of sundry patterns and for various trades.

Robins Conveying Belt Co., New York City.=Illustrated catalogue of belt conveyors, picturing and describing the adaptation and application of the troughed-belt to the conveying of many classes of material, and to the reception and discharge of the material at intermediate points along the length of the conveyor. The mechanical and operative advantages of the system are concisely stated.

Ernest M. Bowden, Earls' Court, London.=Leaflet illustrating and describing a new mechanical movement for transmission of power along slack wires.

Keystone Electric Co., Erie, Pa., U. S. A.=Illustrated descriptive bulletin of direct-current multipolar generators and motors for light and power. The engravings and text are very handsomely printed. Elaborate, but very clear, tables give all data of slow- and medium-speed motors and generators, and diagrams exhibit assembly and foundation, connections, arrangement of belted units, and switchboard connections.

Gas Engine & Power Co., and Charles L. Seabury & Co. (consolidated), Morris Heights, New York City.=Illustrated catalogue of steam and sail yachts, naphtha launches, marine engines, and boilers. The half-tone engravings are unusually good, and represent typical craft built at the company's works. Descriptive text accompanies each.

The Philadelphia Museums, Phila., Pa., U. S. A.=Circular of the Laboratory of Tests and Technology, giving instruction for submitting samples, general information, and schedule of official fees.

University of California, Berkeley, Cal., U.S.A.=Prospectus of the "Phebe Hearst Architectural Plan," an architectural competition for the design of the magnificent new buildings which it is proposed to erect.

The Westinghouse Machine Company, Pittsburg, Pa.=Illustrated descriptive catalogue of Westinghouse gas-engines, setting forth their applications and advantages.

Joseph Dixon Crucible Company, Jersey City, N. J., U. S. A.=Pamphlet, entitled "The Merits of Lead Paints and Dixon's Silica-Graphite Paint Compared."

The Link-Belt Machinery Co., Chicago, Ill., U. S. A.=Illustrated catalogue on heavy paper, devoted to machinery and methods for preparing coal by means of shaking-screens and picking-tables, and to the Luhrig system of washing and classifying coals.

Consolidated Gas Company of New York="The Comfort of Heating by Gas," an illustrated pamphlet, in two colors, devoted to the application of gas-firing to domestic purposes and the use of gas as fuel in all departments of the household. The matter is purely descriptive and suggestive, and gives no exact data.

R. Universita Romana Scuola d' Applicazione per gl' Ingegneri=Annual catalogue, for the scholastic year 1897-98, of the engineering school of the Royal University, Rome. Contains extract from the charter of the University, rules of the school and the library, list of the faculty, calendar, scheme of studies, and list of graduates.

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THE POSSIBILITIES AND LIMITATIONS OF ELECTRIC TRACTION.

By Frank J. Sprague.

IN THE ENGINEERING MAGAZINE of July, 1895, I stated a few conclusions in reply to the query: "Will Trunk Lines be Operated by Electricity?" which were intended as a mild protest against the visionary predictions frequently made, often by men of more than local reputation, because of the remarkable achievements which have marked the advance of electrical science during the past decade. Since then a number of interesting articles have appeared on this subject, among others some in THE ENGINEERING MAGAZINE by Prof. Forbes and Mr. Charles Davis.

Beginning with the somewhat ambitious project of proposing plans for operating the Metropolitan Underground Railway of London, in 1882–3, I have frequently expressed publicly, and more often privately, certain conclusions as to the possibilities and limitations of electric traction, which, in view of many statements recently made, may, with advantage and possible profit, be restated and amplified, especially as they embody the result of more extended experience and maturer judgment, and also in view of my present connection with a radical departure in railway practice only recently declared of present impracticability.

It is not my intention to discuss from a statistical, or even detailed, engineering standpoint the many questions involved in this subject, or to make extended comment on the various articles which have appeared, although, while agreeing in some conclusions, I differ radically in others, but rather to point out, in as simple and direct a

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manner as I may, a few pertinent facts as to present accomplishments and future probabilities.

No subject has been surrounded with more careless predictions or unthinking boasts than that of the application of electricity to trunk-line railway operation, unless it be the transmission of power from Niagara Falls, or the possibilities of inter-planetary communication.

The dynamo or motor, interchangeable terms for the same machine variously proportioned to meet the conditions of duty imposed upon it, has a modern useful life of scarcely a score of years. The use of this remarkable machine as a generator of electricity preceded in a commercial way its use to any wide extent as a motor; only thirteen years have passed since it began to have any standing for stationary-motor purposes, and it has been but nine years since the building of the Richmond and other pioneer electric railways gave the impetus to one of the most remarkable of modern industrial developments, which has afforded one of the main reasons for the glowing predictions of the future of electricity.

From the October, 1897 number of the *Street Railway Journal* I quote, from statistics presented by Mr. Clark, the following facts:

Out of 806 roads in the United States, 33 are operated by steam dummies (not including elevated railroads), 38 by cable, 167 by horses, and 698 by electricity. There are 145 miles of steam dummy track, 515 of cable, 1,010 of horse-car, and 13,580 of electric. There are only one-sixth as many horse cars as there were in 1888, a little more than twice as many cable cars, less steam dummies, and more than two hundred times as many electric cars, there being 37,097 as against 172 in 1888. The average length of the electric system is four and one-half times that of the steam dummy, a third greater than that of the cable, and three times that of the horse-car system.

It may well be asked:

What have been the causes of such an extension of railway activity? Are they the strange and all-powerful attributes of an unknown force, or the natural results of an intelligent and energetic effort to replace certain crude and costly methods of locomotion, tentative at best, and to enter into virgin fields because of ready adaptability to existing needs?

Bearing clearly in mind that electricity is, for the purpose of these remarks, simply a convenient and tractable agent for the practically-instantaneous transmission of power from one or more points to others, in any required amount and with any desired concentration, it was evident that the battle of the horse car and electric trolley was sure to end in an easy victory for the latter the moment it could be intelligently and safely introduced, and apparatus could be made to meet the commercial requirements, for the advantages of lessened cost of power, greater speed, and increased capacity of units were all with the motor.

The cable,—despite certain limited advantages in some favored localities,—because of its great cost, fixity of speed, and localization of routes, is naturally following the horse car to the realms of the obsolescent.

Virgin fields opened up for new lines because of reasonable first cost, prospect of return on investment, and the many advantages offered by a rapid, clean, house-to-house service, and in these fields there has been no rival worth mentioning, despite the many futile efforts in behalf of gas and compressed-air motors.

Now, however, we have come to the consideration of the field occupied until recently almost exclusively by steam, and it may as well at once be realized that a modern giant is confronted, intrenched behind a complicated and an almost impregnable system of operation, which is the growth of years and the product of necessary conditions.

It has been said that "the throb of the locomotive is the heartbeat of civilization." I might paraphrase this, and say that the hum of the electric motor is a song of emancipation, but rather the emancipation of men and beasts, not of all steam apparatus, or at least not until fuel conditions shall make necessary the adoption of electricity and the utilization, even at increased cost over present practice, of waterfalls or tide-movements.

The term "trunk line" needs popular definition. It cannot be properly applied to all steam roads, but has a limitation defined by its very breadth. For the purpose of stating some conclusions, transportation lines may be divided as follows:

Street car or surface city and town lines;

Elevated or underground railroads;

Suburban lines;

Inter-urban lines,—the foregoing all devoted primarily to passenger traffic;

Independent steam lines;

Inter-connecting systems,—the last two handling both freight and passenger service.

A trunk line may be defined as a sort of main railway artery, with branch and connecting lines, terminal facilities, signal systems, in fact, all the varied equipment necessary for complete railroad operation, and used for carrying freight and passengers, both local and through, and with interchange of freight and passenger traffic and cars.

It will be immediately apparent to the most casual observer that the conditions surrounding the various services mentioned are in many particulars radically different, and the reasons which may make advisable, or even necessary, the adoption of electric traction in some cases might make it absolutely prohibitory in others.

Again, the problems involved in the substitution of power and alteration of traffic conditions on old lines are of an entirely different sort from those involved in the creation of new lines to meet existing or hoped-for conditions.

On the street-car question I shall touch only briefly. For this service some one of various electric applications,— the overhead trolley, the slotted conduit, the button system, and the storage battery, singly or in combination,—for they are all practical to-day under certain limitations, and according to the needs of each particular case,—will be used almost exclusively.

All elevated railways, despite the lamentable inertia of the great Manhattan system of New York, are ripe for electrical application, and one needs but to inspect the Liverpool Overhead Railway, the more extensive examples of the Metropolitan and Lake Street Elevateds of Chicago, the writer's most modern equipment of the South Side Elevated of the same city, now being changed from steam to electricity, the service of the Brooklyn Bridge, and the proposed changes on the Brooklyn and the Kings County Elevated Railroads, to make evident the near-coming end of steam-locomotive operation for this kind of service.

Of underground systems, the Metropolitan of London is destined to be changed by virtue of necessity; the City & South London Road has now been in operation for some time; the Central London Railway is under construction; and, as other extensive roads proposed in London, as well as that outlined by the Rapid Transit Commission of New York, all contemplate electric equipments, there remains no room for argument, nor has there been for a long time, as I have frequently pointed out, as to the utility of electricity for this class of service.

We have now to consider suburban lines, in which of course many extensions of street-car lines may be classed, and for which many new electrics have been built. New and old railroad systems must invariably be considered from a different standpoint, and at the moment I have in mind the general conception of a suburban line as that branch of a general railroad system which operates, wholly or in part, over the same tracks as the main-line trains or tracks contiguous thereto, is protected by the same signal system, uses the same or additional stations, is operated by the same class of equipment under the usual steam conditions, and is subject to the established routine of steam-railway management.

Just here I may briefly state some well-settled facts in reference to the electric motor.

Its design and manufacture now present no particular difficulties. It can be built, singly or in combination, of any desired power per unit. It is reliable; it has a smoother torque than a locomotive, and can be worked for longer hours; it can be controlled automatically or at will, in one or more units, and by less skilled labor. Measured by car-miles, its depreciation is less. Its cost is reasonable, but will be still further reduced—although probably not very radically.

Again, power can be generated and distributed to any reasonable distance in any required amount and at well-known efficiencies, and with known elements of cost of installation, whether from a water or steam source of power. All this may be granted without question, because the facts are proven by that most practical of all tests, daily experience.

Until recently, although the possibilities of a different practice, having for certain work many advantages, have been pointed out frequently, there have been but two practical methods of using electric motors for railway purposes. One was the equipment of one or both axles of a car with motors controlling them from either end, making use in the last case of the full weight for rapid acceleration, and operating the car singly. The other was the construction of a special locomotive—as for example, that built for the Baltimore & Ohio Tunnel, or a locomotive passenger car on the general lines of one that I built in 1887, and as now used on the Metropolitan Elevated Railway of Chicago—to pull other unequipped cars or trailers, thus following the general lines of steam practice.

In 1887, in a paper read before the Society of Arts in Boston, I discussed the particular characteristics of the Third Avenue division of the New York Manhattan Elevated Railroad, and predicted the possibilities of fuel saving, although the engines were already developing a horse-power hour for about six pounds of coal, and the cost of fuel was only six and one-half cents per train-mile. In addition, I particularly pointed out, although in an incomplete manner, certain advantages which would accrue by the distribution of the motive power, having a motor on every axle and having some method of simultaneous control of all motors, among these advantages being independent equipment, shortened time intervals, unlimited length of trains, high tractive and accelerative effort, reduced strains, smoother motion, etc.

The time was not ripe for so radical a departure,—it was even before the troublous days of Richmond,—but time and again I referred to the possibility of this sort of an equipment, and stated later that, "when motors reach their highest standard, every car can be made an individual unit, which can be operated in any combination and from any point of a train."

While not yet at the "highest" standard, the electric motor has reached such an excellence of manufacture and performance that this ideal, individualization of equipment of passenger cars, is now not only possible, but in many instances most advisable. Despite this fact, and although actually pointing out certain advantages by such an application, I find Mr. Davis declaring in somewhat positive fashion, as late as June, 1897, in THE ENGINEERING MAGAZINE, that "the system is not possible to-day," and thereafter basing a number of elaborate conclusions on a service at extraordinary speed between New York and Philadelphia upon a train system. I stated some years ago that, from a financial standpoint of investment and operation, a high-speed service between these cities was now a practical and commercial possibility, if the individualized system of car-equipment were adopted, and I have no reason to change the conclusion.

It is an interesting commentary upon the fallacy of negative prophecy concerning electric projects which do not propose to violate sound laws that, when Mr. Davis's statement was published, the writer was under personal contract with the South Side Elevated Railway of Chicago, then operating with an equipment of Baldwin compound 28-ton locomotives and standard passenger coaches, to equip 120 cars with an aggregate of 12,000 h. p. on an absolutely individualized system, using an average of 60 per cent. of the weight of each car, the contract specifying, as a condition, the ability to join cars in any desired number, sequence, or end relation, and to perfectly and equally control trains from either end of any car; that two cars were actually so operated on the 16th of July; that a public demonstration of the operation of a six-car train, so equipped, with a ten year-old boy at the operating lever, was made on the 26th of July in Schenectady,—the fiftieth anniversary of the first public exhibition of an electric motor operating a car made by the lamented Moses G. Farmer, in Dover, N. H.; and that on this very date public question of the practicability of such a system was made at the meeting of the American Institute of Electric Engineers by no less a scientist than Prof. Thomson.

Such a train has now for some time been in daily operation, its trips being intermingled with those of electric and steam locomotive trains, its official test has been accepted, and the change from steam to electric operation will be made with the same cars and with both systems operated over the same tracks for a considerable period.

My own experience warrants me in predicting for this system, constituting as it does a radical departure from all previous practice, a future as important as that marked by the advent of the trolley, and suggests the further prediction that Chicago will be the Richmond of the new development.

Despite the many advantages which could be gained by the use of distributed motors, if the difficulties of simultaneous and complete control were overcome and what I have termed a "multiple-unit control were established," I did not fully realize all the possible results until I had the good fortune to be brought into contact with a remarkable series of investigations, embracing all the conditions of railway practice, made by Mr. John Lundie of Chicago, the consulting engineer of the Illinois Central Railroad, while considering the possibility of applying electricity to that road's suburban service; nor did I fully realize to its full the importance of a remarkably quick acceleration from the standpoints of economic power and transportation.

Mr. Lundie was the first engineer to bring out clearly, or even markedly, the fact that on suburban service, or any service requiring frequent stops at short intervals, any given schedule can be made most economically by attaining a very high rate of acceleration—unless interfering seriously with economic production; that, with given station stops, cost of equipment, established costs of coal and labor, and rate of depreciation, there is a rate acceleration coincident with a minimum cost of operation; and that, although the rate in the particular case of the Illinois Central is so great that it at first seemed almost startling,—amounting to forty miles in twenty seconds for an eighty-ton train,—and therefore involves an immense local current demand for a few seconds, such demand was perfectly permissible if the station was supplemented by a storage battery of high discharge capacity. It is safe to say that the future of the Illinois Central operations will warrant the very careful attention of both steam and electrical engineers and railway managers.

Touching briefly upon the question of suburban service, a few facts should be borne in mind. On competitive service particularly, with established routes and stations, traffic is affected primarily by rate of fare, frequency of service, and schedule-speed. A shortening in schedule time is of vastly more importance than any possible saving in power. The quicker the acceleration, the less the maximum speed required for any given schedule, and the less the amount thrown away in braking.

As the length of station intervals increases, the importance of rapid acceleration naturally decreases. The shortening of time at stations is vitally important on short-interval service, and hence provision for rapid loading and unloading of passengers is of great importance, for every second cut off from the running time between stations, with any given schedule, by station waits, increases the power-consumption and the required motor-capacity in a much greater ratio.

Since a multiple-unit system of control will enable suburban service to be operated with all the advantages briefly indicated, the displacement of the steam locomotive, in fact all locomotives, seems here assured.

The consideration of the larger problem involved in the application of electric power to trunk-railway service will be reserved for the February issue of THE ENGINEERING MAGAZINE.

SHIP-BUILDING AS A PRODUCTIVE INDUSTRY IN GREAT BRITAIN.

By James McKechnie.

II.—THE RECIPROCAL INFLUENCE OF PRIVATE ENTERPRISE AND NAVAL DOMINION.

IN my first article I sought to show the financial value to Britain of her ship-building industry from the labour, as well as the national, point of view; but there are also strategic considerations. It is largely because England has a ship-building, and therefore a shipping, industry that she needs a naval fleet; and the medium which creates the necessity insures the facility for meeting the need. The royal dock yards are admirable in every respect save capacity. You cannot put a quart into a pint pot. But I cannot deny myself the pleasure of referring to the splendid public services of the naval constructors and engineers who preside over these royal establishments, especially as they seldom receive honourable mention. On them depends more than is known to the public whom they serve, and only the ship-builder and engineer brought into contact with them can appraise their services. They are responsible for much public money, and spend it well. Portsmouth is the biggest of English yards, and the number of vessels launched during the past seven years has been twelve of 108,685 tons, while more than a million pounds sterling are spent in wages in a year, and seven hundred thousand pounds are disbursed for material. Mr. J. A. Yates is the chief constructor, and Mr. John T. Corner the chief engineer. Chatham comes next in importance; there the seven years' total is eleven vessels of 94,530 tons, while one million sterling is spent annually on wages and material. As at Portsmouth, three battle-ships and three cruisers may be simultaneously in process of construction, although the maximum is seldom reached. Mr. W. James is the chief constructor, and Mr. W. G. Littlejohns the chief engineer. From Devonport, which promises, with the addition of Keyham, to be an enormous establishment, there have been launched in seven years sixteen vessels of 52,500 tons. There more than half a million per annum is spent well, Mr. H. R. Champness being chief constructor and Mr. R. Mayston chief engineer. At Pembroke, where in seven years eight vessels of 67,915 tons have been launched, Mr. H. Cock is chief constructor, while at Sheerness the offices are filled respectively by Mr. H. H. Ash and Mr. R. H. Andrews. It is also well to

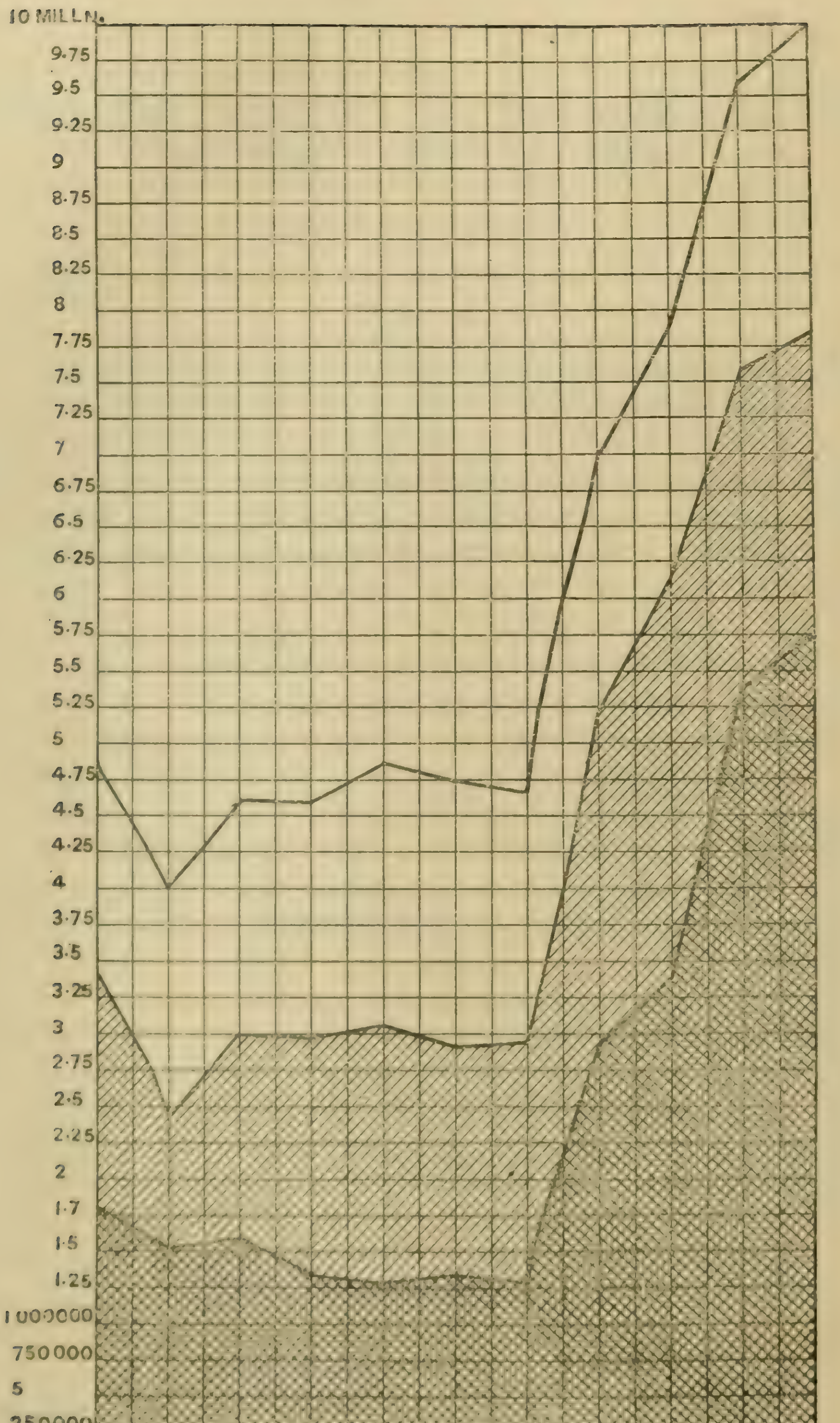


DIAGRAM SHOWING DISBURSEMENT AND DISTRIBUTION OF MONEY FOR NAVAL CONSTRUCTION.

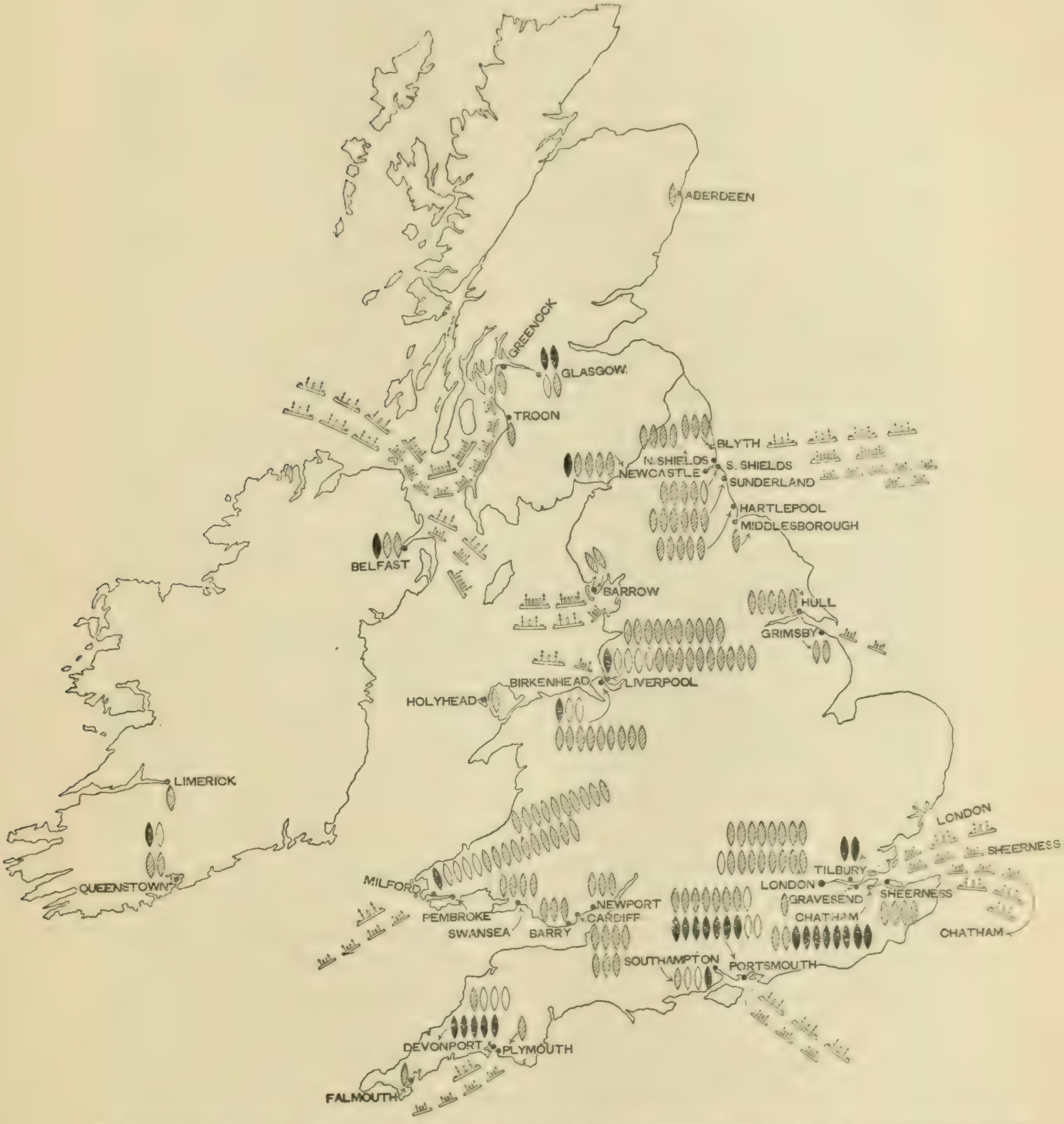
speak of the inspectors of machinery, who are important officials from the national point of view, for, should their vigilance relax, danger might be discovered only in the hour of peril. Messrs. H. J. Oram, J. Wooton, C. B., J. A. Bedbrook, and J. J. Finch are men well tried in the profession, and on their judgment full reliance may be placed.

These royal yards are conveniently situated from the strategic standpoint, no matter by what power England may be opposed; but there is a wide extent of coast without any government establishment, and here the private works, because of their wide distribution, will be of immense value. I have prepared a diagram which shows at a glance the money disbursed for new construction, including guns, for the navy, and the division of it between (1) contractors for ships and engines, (2) firms supplying material for ships, etc., built in the dock yard, and (3) laborers in the royal dock yards. This shows in a striking manner the great activity in war-ship-building in recent years. The cross-hatching shows the money spent for private ship-building and engineering firms, approximately one-half of the total; the section-lining the expenditure on material; the remainder the wages paid in the royal yard. It might easily be reckoned that the establishments capable of doing thoroughly reliable work have double the capacity of the dock yards, alike for construction and for repairs. The strategical value is, therefore, great, for, as I have already contended, victory will ultimately rest, not so much with the nation which may gain the first advantage, as with the one having the greatest recuperative powers. Sir William H. White, who is unquestionably the best and, I will add, a scrupulously accurate authority, says England can build so much faster than other nations that he can afford to wait until he sees their designs before proceeding with his work, and yet have his improved ship ready first. The same applies to repair work.

The docking facilities afforded round the coast, principally by or as a result of ship-builders' energy, add materially to the value from the strategical standpoint. In the map of the British Isles on page 565 I have shown at the various centers the number and size of the docks suitable for warships. Battle-ship docks are shown within the boundary line by a plan in black, large cruisers by a plan in white, and second-class cruisers by a striped plan. These do not by any means represent the total number of docks. In all, two hundred and forty-eight might have been indicated; many of them are of great length, but have unfortunately too little depth of water on the entrance sill. Thus, for instance, in some of the merchant shipping centers there are docks six hundred feet long with only twenty-two feet of water on the entrance sill. Such must obviously be classed as for second-class cruisers drawing from 16 to 20 feet. There is a typical case at the James Watt dock in Greenock, where the length is 535 feet with a draught of only 20 feet on the sill and a width of 60½ feet. This may suit modern steamers, which are docked when light, but not warships, whose width and depth are the limiting dimensions. Length of ship is restricted, in order to reduce the target and the length of armoured area; to minimise draught for a given weight, great beam is necessary. Thus 75 and 76 feet beam and 25 to 27 feet draught have to be reckoned with. I have shown battle-ship docks in black and large-cruiser docks in white; but the latter may in most cases be used for battle-ships, although some of the battle-ship docks are too short for big cruisers. Many of these docks belong to ship-builders, and, as a rule, repair-facilities are at hand. There are few navigating difficulties, except at the Bristol channel, where the range of tide is, say, at Barry 28 feet; it is subject for expert consideration whether the current might not involve danger and make the few docks of the channel of doubtful utility for heavy ships. But there are, in any case, sufficient facilities well distributed around the British coast for docking one hundred cruisers and about forty-five battle-ships, or large cruisers. The remaining one hundred odd docks would be suitable for small craft, gunboats, and destroyers. In some cases the docks would accommodate two vessels, one abaft the other.

And now as to the war-ship-building capacity of private yards. Most sanguine estimates, I know, have been made—in some cases without even reference to the number of building-berths. It is idle to assume that in the hour of need every firm will have all their best berths vacant, and, when it is remembered that a weight of six thousand tons has to be supported on a small area, before and up to the time of launching, it will be understood that any ground will not suffice, while on the Clyde and Tyne the launching-water area is restricted in the case of some of the berths. Again, experience, alike on the part of the management and the men, is necessary to build a big cruiser or battle-ship. This cannot be acquired in a day; consequently I have included only firms that have done heavy work. Their task is made so easy by the skill and forethought of Sir William White, the director of naval construction, and Sir John Durston, the engineer-in-chief, that the firms may be depended upon for much. I have taken these points into consideration in filling in, upon the map, a sketch of the fleets which might be created at each port in two years or even less. Battle-ships are shown with one funnel, first-class cruisers with four funnels, second-class cruisers with three

THE SHIP-BUILDING AND DOCKING FACILITIES OF BRITAIN.



MAP SHOWING DOCKS FOR WARSHIPS, AND LARGE WARSHIPS THAT MAY BE BUILT IN 2 YEARS

DOCKS DRAWN ● ARE FOR BATTLESHIPS, ○ FOR LARGE CRUISERS, ▨ FOR 2ND CLASS, CRUISERS

SHIPS BUILT IN 2 YEARS – BATTLESHIPS, – 1ST CLASS CRUISERS, – 2ND CLASS CRUISERS funnels. Needless to say, their scale is a trifle larger than the scale of the map. I have not included small craft, of which a large fleet might simultaneously be constructed. Each district, too, would give some help to the government yards in providing the engines. I think the readers in other lands than Britain will agree that the map proves the greatness of the British ship-building industry.

In preparing this map, I have had help from the three hundred odd pages of the navy estimates, which always yield a wealth of suggestive data. The cynic may say that that is why the accountants make it so obscure; even so, gold is always hardly won. From this mass and other sources I have gathered many interesting facts, and especially the amount of money distributed to each district and firm for modern war-ships. With the view of investigating what I might term the migration of industry, I have separated the receipts of the various districts into three periods: (1) the years preceding the naval defence act; (2) the years included in its operation; (3) the years subsequent to it. It is not a very unequal division, owing to recent activity, and the ships included are only those on the list of serviceable vessels. The first period accounts for nearly nineteen millions' sterling of contract work; the second for more than ten millions; and the third for nearly eighteen millions. This takes no account of dock-yard work or the material required for it; but it includes propelling machinery for dock-yard ships.

The most striking point of the analysis is the decadence of shipbuilding in London. In the first period more than half of the naval money voted to contractors was disbursed in the metropolis; under the naval defence act it dropped to less than one-fifth; in the third period it is only 15 to 16 per cent. Instead of securing nine millions' sterling for naval purposes, as it would have done had the proportion in the third period been the same as in the first, London received only about three millions, including torpedo-boat destroyers. The Clyde has increased her share greatly. In the first period she received 26.6 per cent.; in the second practically the same; in the current period 39.2 per cent. The general tendency on the Tyne is not so clearly defined. Two considerations account for this. Elswick has lately done little for the British admiralty, preferring the work of other governments, which allows them to supply the guns direct. Palmer's Company, in the naval-defence-act period, had two battle-ships which have no counterpart in the current period. Thus the ratios in the three periods vary,—15, 28.8, and 8.3 per cent. respectively. The Mersey has also improved its position, but this is due entirely to the ever-successful efforts of the old firm of Messrs. Laird Brothers. They are almost alone as representatives of the

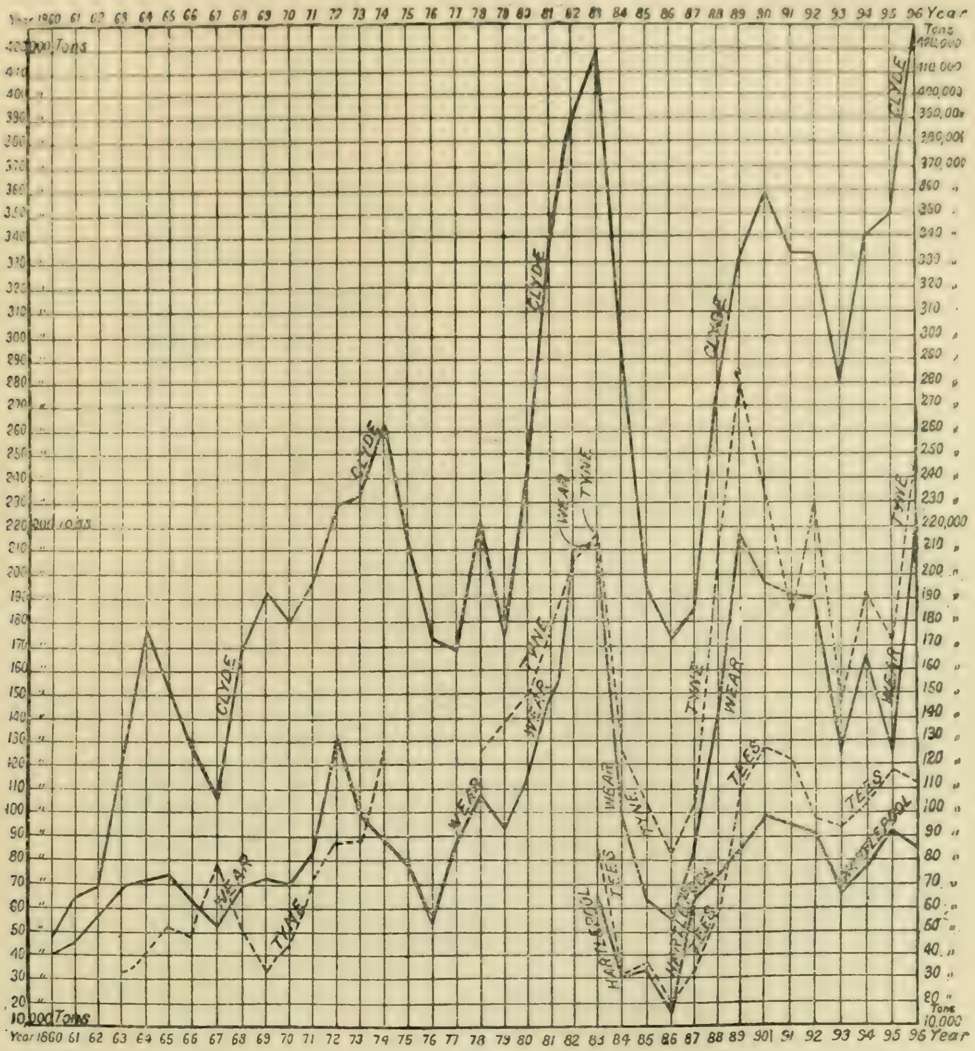


DIAGRAM OF PRODUCTION OF NEW SHIPPING IN PRINCIPAL PORTS OF UNITED KINGDOM.

The horizontal lines each represent 10,000 tons and each vertical line a year. Reliable statistics are not available for the Tyne for all years prior to 1878.

industry. In the first period they had 1.27 per cent., in the second 10 per cent., and in the current period 13.65 per cent. Hull, like the Tyne, has varied; it had considerable work under the naval defence act, getting 8.8 per cent. of the total spent on contract work, while in the preceding period it had only 3.09, and in the current period 3.42 per cent. Mr. Seaton's energy obviously is not relaxed.

Peculiarly satisfactory is the position of Barrow, where there is only one works—owned by Messrs. Vickers, Sons & Maxim, Limited. Prior to 1889 there was earned only a quarter of a million sterling, but under the naval defence act, a much shorter period, nearly three times that was received, or 6.7 per cent. for the kingdom, while in

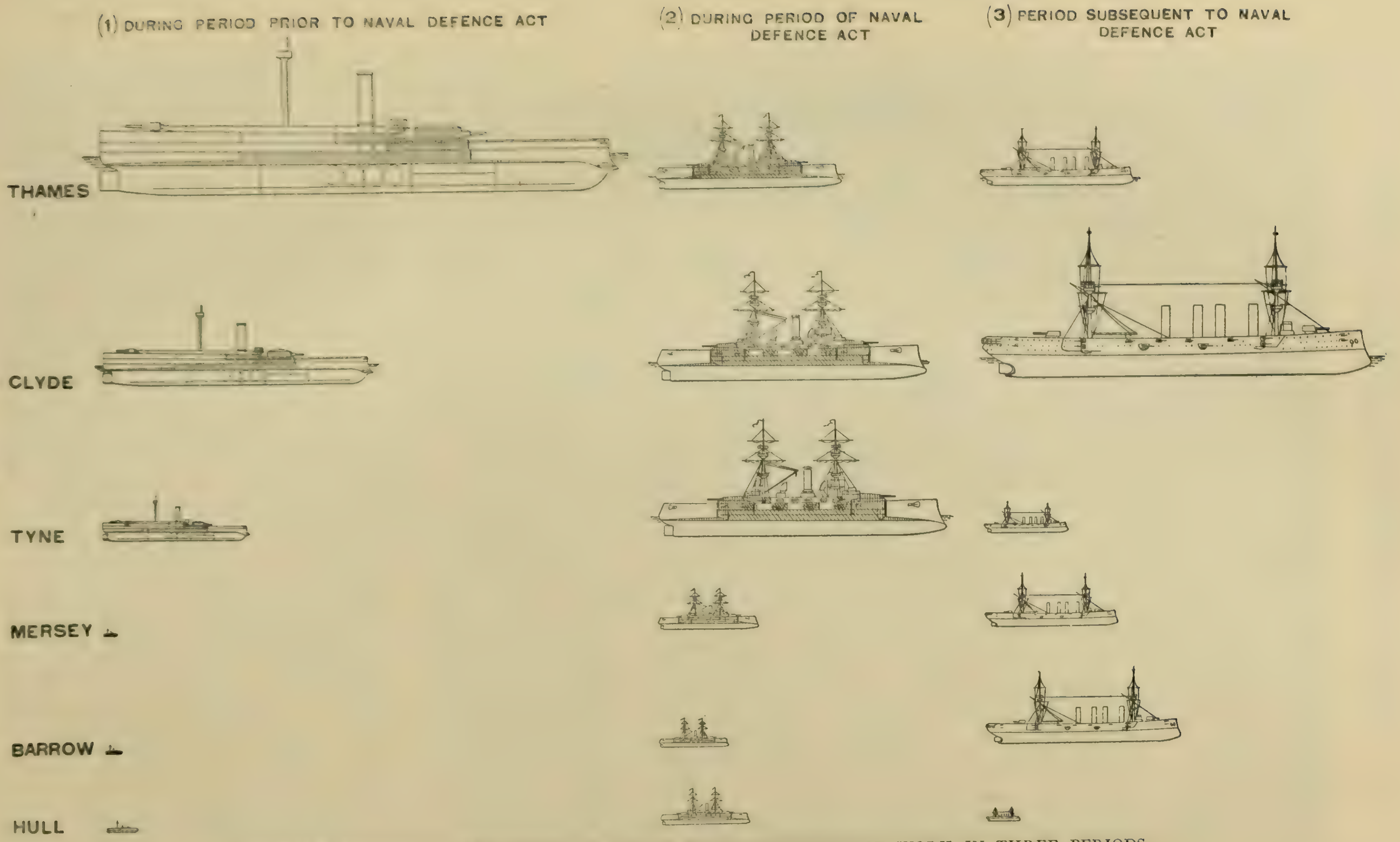


DIAGRAM SHOWING DISTRIBUTION OF MONEY FOR NAVY-CONTRACT WORK IN THREE PERIODS.

It will be seen that in the first period the Thames took twice as much as the Clyde, but in the second period only two-thirds as much as the Clyde or the Tyne. In the third period the Clyde takes four-fifths of the total, and more than double the Thames. The progress of Barrow is most marked. The proportion in each case is denoted by the length of the ship.

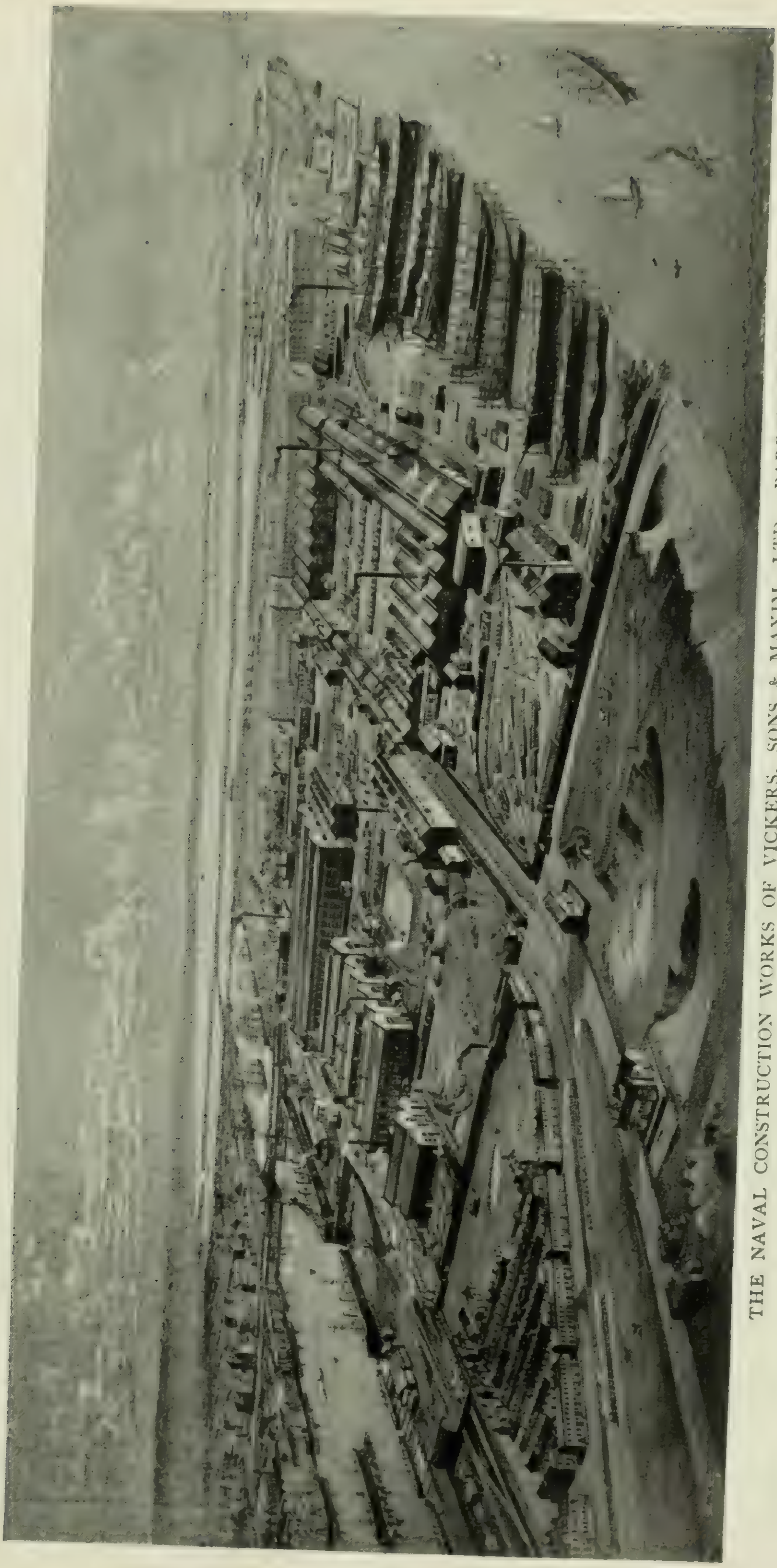
the current period the total was more than £3,500,000 sterling, or nearly 20 per cent. of the amount distributed to contractors throughout the kingdom. The influence of the late Mr. Bryce Douglas, and especially of Mr. Alexander Adamson, the present managing director, is clearly traceable here.

I have shown diagrammatically the position in the several districts. The first period is represented by an old type of battle-ship; the other two periods are represented by modern creations,—the Magnificent and the Powerful. The diagram will be readily understood. The size of the ships, reading downwards, shows the relation of one district to the other, and, reading across the page, the growth or decline, in the three periods, of each district. Thus the growth in the case of the Clyde and Barrow is seen at a glance.

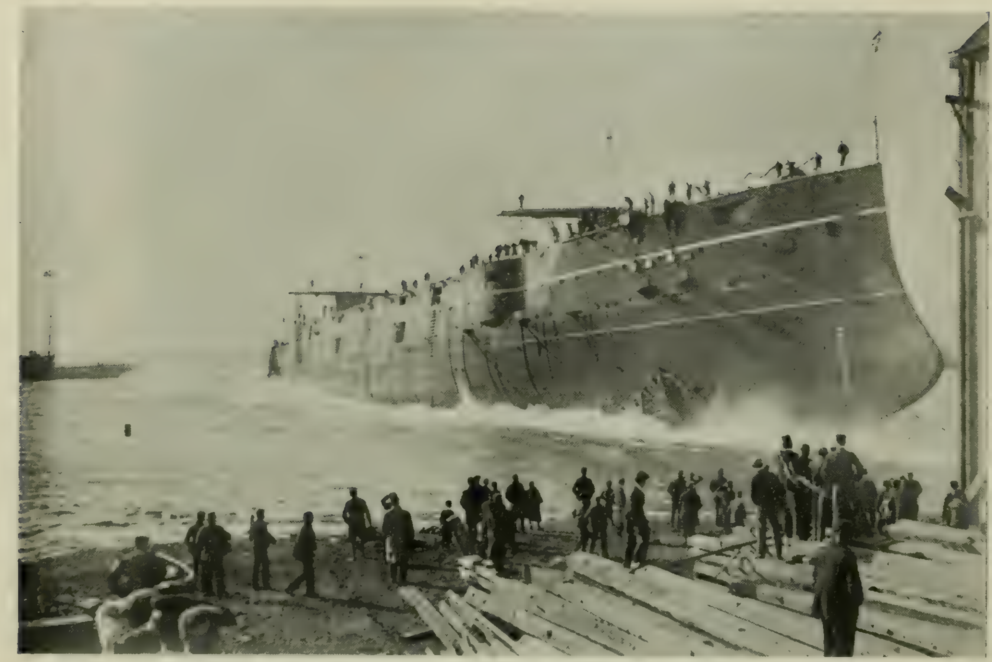
THE NEW FIRST CLASS BRITISH CRUISER "NIOBE," 11,000 TONS.
Built by Vickers, Sons & Maxim, Barrow-in-Furness.

If the figures for individual firms be taken separately, it is found that in the latest of the three periods the Naval Construction Works at Barrow occupy first place. Since 1893 the admiralty have entrusted this firm with vessels whose aggregate value, excluding guns, amounts to a little more than £3,500,000 sterling. These include every type; the first class battle-ship, "Vengeance;" the 14,300-ton cruiser, "Powerful;" two 11,000-ton cruisers, "Niobe" and "Amphitrite;" the 5,600-ton cruisers, "Juno" and "Doris;" and several 30-knot destroyers,—an aggregate tonnage of 62,345 and a collective power of 140,200 i. h. p. These figures are suggestive of many problems in boiler, engine, and propeller design. The record, of which the management may be proud, largely explains the purchase of the works by the famous armour- and gun-makers, Vickers Sons & Company, Limited, Sheffield. The combination, especially as it includes the works of the Maxim-Nordenfelt Gun and Ammunition Company, must have far-reaching effects, as it enables the company to construct any ship of war without outside help, they themselves supplying constructive material (including armour, forgings, and castings), guns, with mountings and ammunition, and electric gear for all purposes. The influence in the direction of economy and speed of construction can scarcely be exaggerated, especially under a chief who, in America, would be styled a king of mechanics; it is only a suggestion of greatness that he is best known in England by his company as Mr. Tom Vickers. It is an open secret that the aim is to compete not only for every type of British, but also for foreign, war-ship work. In the latter case armour, armament, ammunition, and all stores are included in the one specification; in contracts for British ships these items are separate.

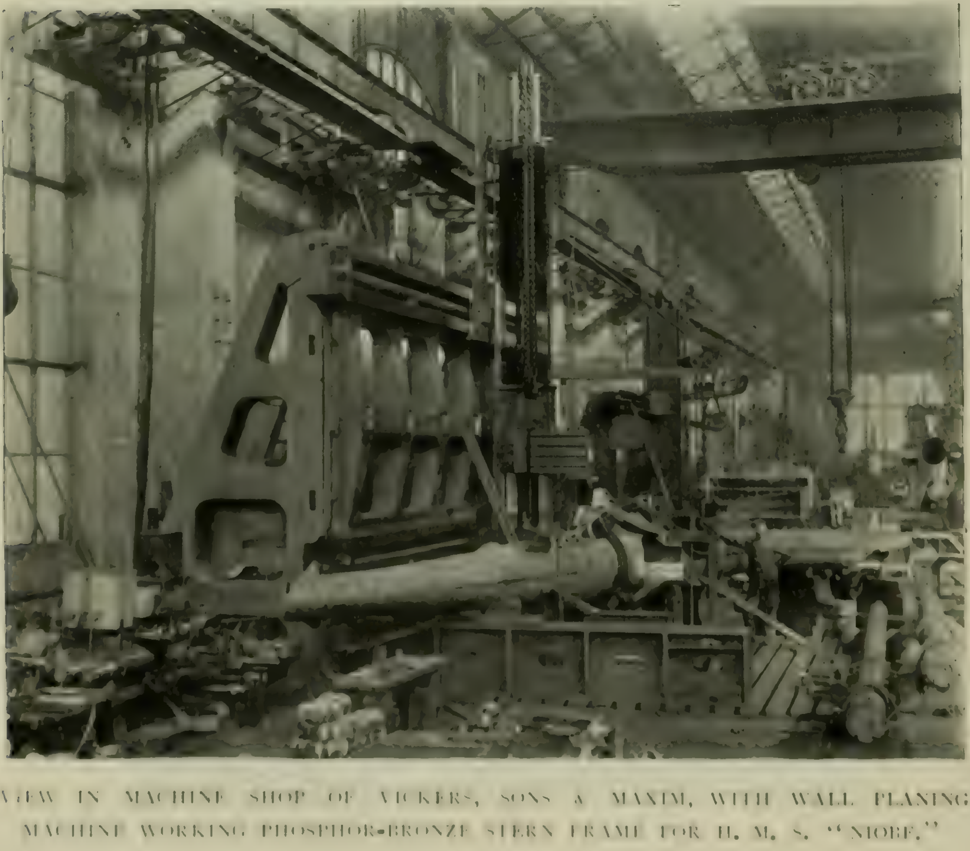
FITTING-OUT DOCK AT NAVAL CONSTRUCTION WORKS OF VICKERS, SONS & MAXIM. H. M. S. "Doris," "Powerful" and "Juno" at the 100-ton crane.



THE NAVAL CONSTRUCTION WORKS OF VICKERS, SONS & MAXIM, LTD., BARROW-IN-FURNESS.



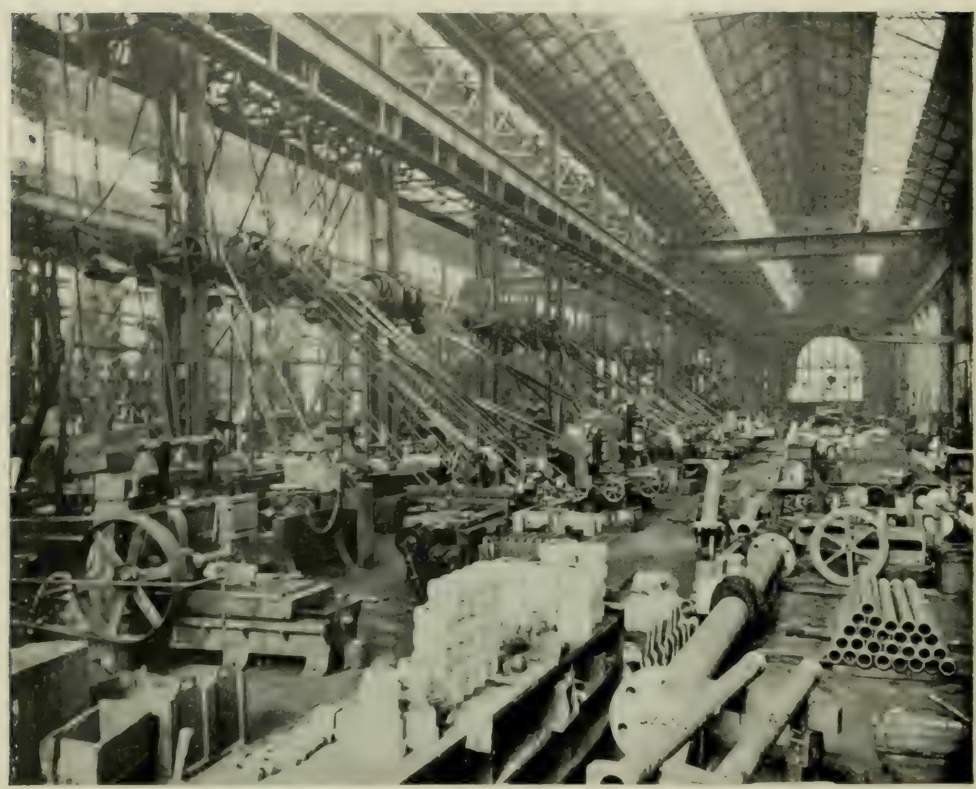
LAUNCH OF H. M. S. "NIOBE."



VIEW IN MACHINE SHOP OF VICKERS, SONS & MAXIM, WITH WALL PLANING MACHINE WORKING PHOSPHOR-BRONZE STERN FRAME FOR H. M. S. "NIOBE."

The counterpart of this Vickers' combination is found perhaps more in Krupp, of Germany, than in Sir W. G. Armstrong, Whitworth & Co., but the Germania Ship-building Establishment of the Krupp Company has not the reputation or the facilities of the Barrow works, while the Armstrong-Whitworth Amalgamation, although the Elswick yard (organized originally by Sir William White before he became director of naval construction) is admirably equipped, is yet without marine engineering works. This may be remedied; already there are expectations of its taking over the Wallsend Engineering Works, now under the direct management of Mr. Andrew Laing, formerly of Fairfield. He, with characteristic energy, has reconstructed them, and is building his first set of destroyers' engines there for Elswick; but against this view there is the long association between Lord Armstrong's company and Humphreys Tennant & Co., the famous London engineers who have for so long engined Elswick warships, and have a splendid shop—probably the best in London. The disadvantage, however, of building engines in London for ships

ENGINE-FITTING SHOP AND ENGINE ERECTING PITS, VICKERS, SONS & MAXIM.



VIEW IN THE ENGINE SHOP, VICKERS SONS & MAXIM.

constructed and completed at Newcastle, two hundred and fifty miles distant, need only be suggested to be appreciated. In any case both the Vickers and the Armstrong-Whitworth combinations must be powerful factors in maintaining the supremacy of British naval ship-building against the best competitors in the world, and it is not improbable that even the British government may find it economical and efficient to give in the one contract an order for a ship ready for action, after the policy which, as already indicated, is frequently pursued by other governments, and thus utilize the benefits of concentration of management.

Elswick, where Captain Noble and Mr. F. Watts are important factors in success, has devoted most attention to foreign work ; in recent years it has had a splendid record, but I cannot enter into an analysis of the ships, as I am concerned here only with the advantage of Britain's ship-building industry to her naval supremacy. The Clydebank works, to which I referred in my previous article, have had a long series of successes. Indeed, the analysis of the competition of the British fleet of to-day shows that this company, among contractors, received the largest amount of money, its connection extending over a longer period than that of most of the other firms.

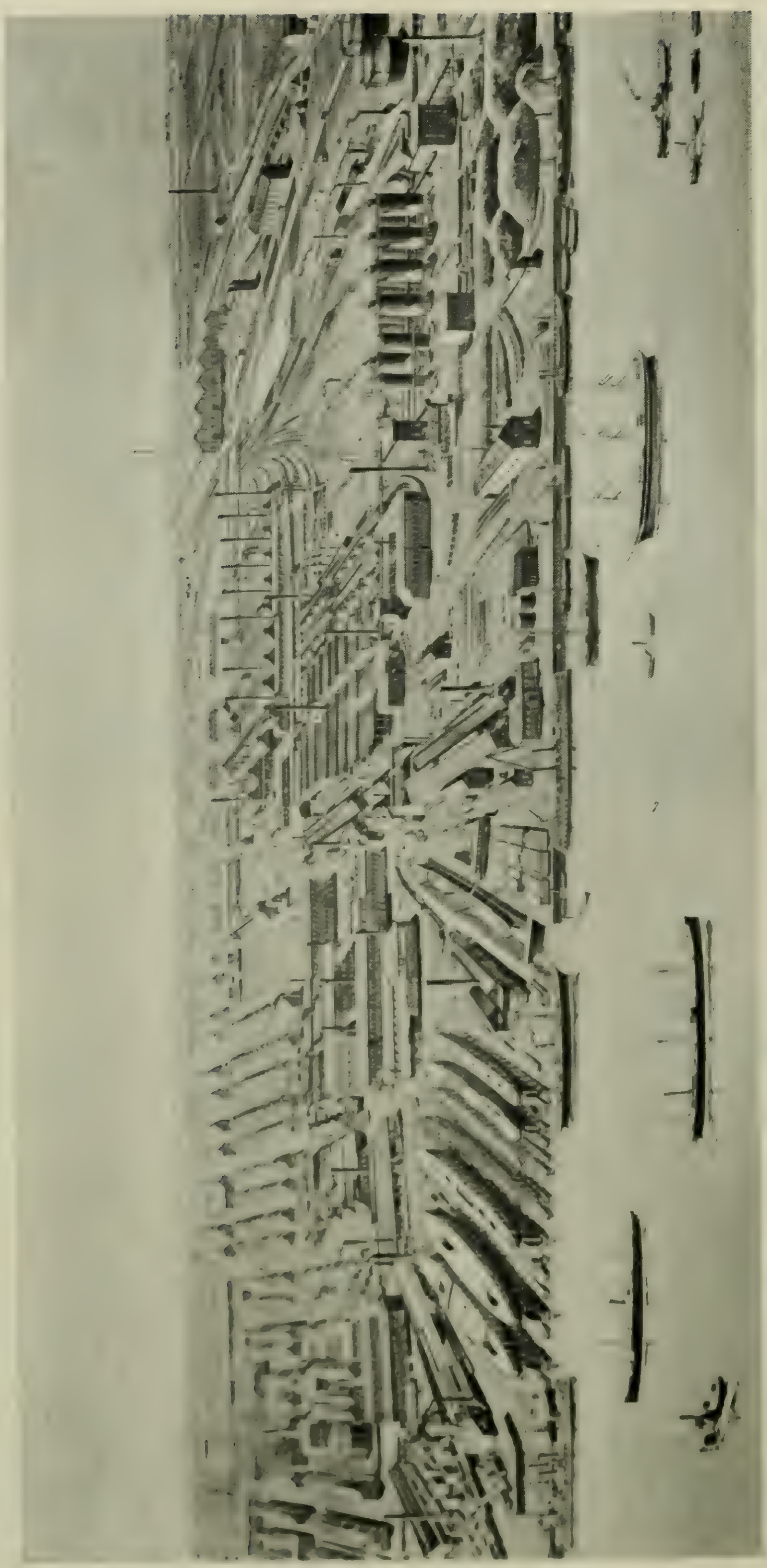
It has taken, in all, about £5,750,000 sterling. Its naval-defence-act contributions included a battle-ship and three second-class cruisers, with engines for others; since then it has secured work amounting to £3,400,000 sterling.

The Fairfield Company, of which Dr. F. Elgar is a director and Mr. Edmund Sharer and Mr. Alex. Gracie are departmental managers, is also taking a prominent place. It engined only three vessels for the naval-defence-act fleet, but in recent years has had orders for work valued at more than £2,500,000 sterling. This includes two cruisers of 11,000 tons, to steam 20½ knots, similar to vessels built at Barrow and Clydebank, and also four 5,600-ton-cruisers. Although perhaps superfluous, it should be stated that British firms secure orders purely upon financial considerations,—their ability to complete them having been previously determined,—and it is commendation of the fulness and definiteness of specifications, and also of the great experience of the three firms, that the tenders sent in by the Barrow, Clydebank, and Fairfield establishments for the Amphitrite, Ariadne, and Argonaut, respectively, showed a difference between top and bottom prices of barely 0.5 per cent. of the total. True, each had one similar vessel under order, but not at a stage where accurate costs could be worked out. There was no collusion; that I can guarantee. The spirit of friendly rivalry is too great.

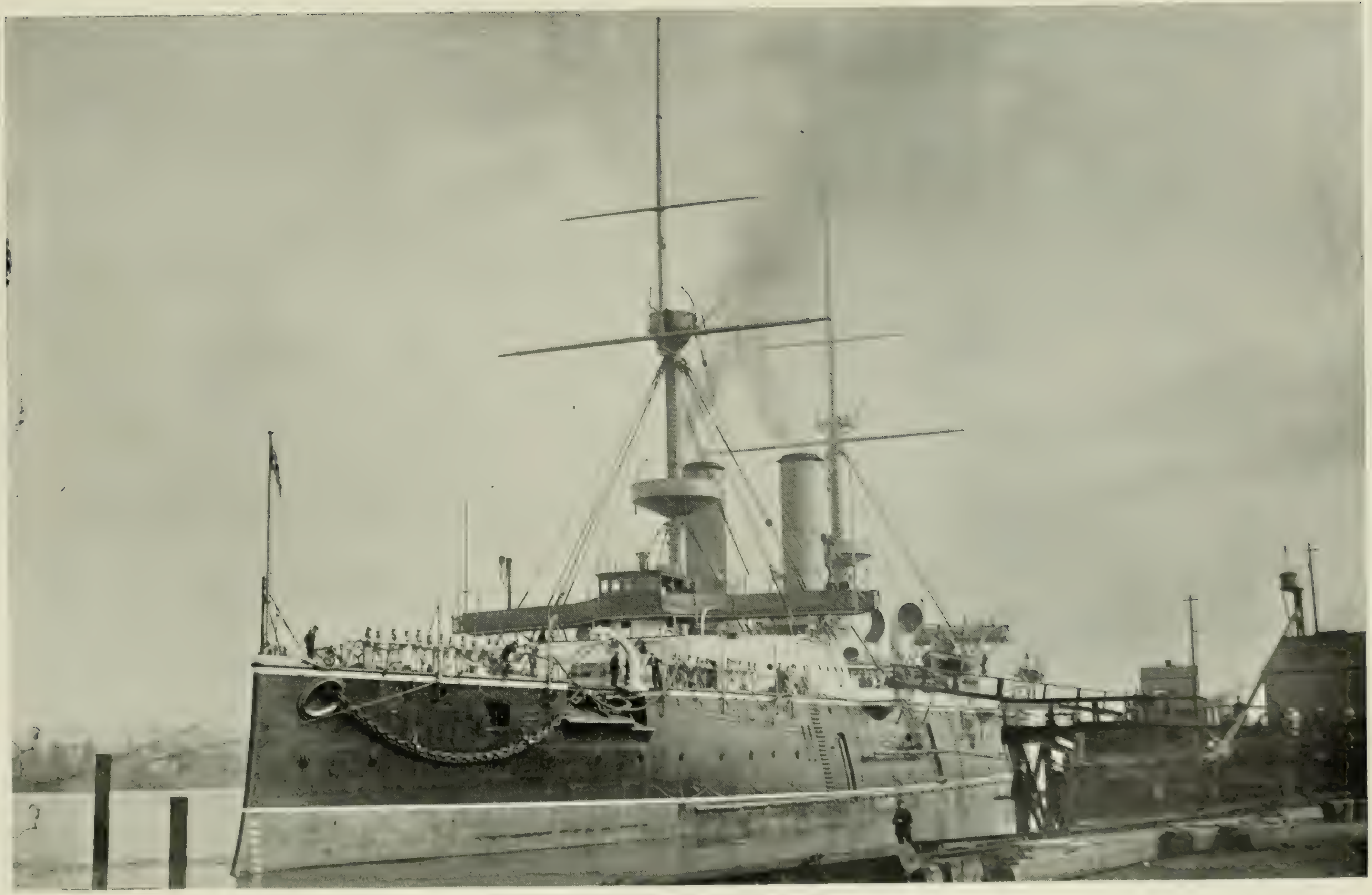
To Messrs. Laird's position I have already referred. The Palmer Shipbuilding Co., whose departmental managers are Mr. J. W. Reed and Mr. J. Dugdale, with Mr. J. P. Wilson as technical adviser, has built only two small cruisers and a fleet of destroyers; but the re-

A JAPANESE CRUISER.

Built by the Clydebank Shipbuilding and Engineering Co., Ltd.



BIRD'S-EYE VIEW OF PALMER'S SHIPBUILDING AND IRON CO., LTD., JARROW-ON-TYNE.



H. M. FIRST CLASS BATTLE SHIP "REVENGE" ALONGSIDE THE JETTY.

Built by Palmer's Shipbuilding and Iron Co., Ltd., Jarrow-on-Tyne.

H. M. S. "REVENGE," READY FOR LAUNCHING.
Built by Palmer's Shipbuilding and Iron Co., Ltd.

sources of their establishment are reflected by the fact that they netted a larger share of the naval-defence-act contract sum than did any other firm, and in all have taken nearly five millions for the fleet as it stands to-day. Messrs. Napier, of Glasgow, have in recent years preferred merchant work, but they have a long and highly creditable record. A historical interest, too, attaches to their establishment, for there Robert Napier built his first marine engine in 1824, and the machinery for all the Cunard steamers built between 1840 and 1860. It indicates the change in methods to state that the drawings for most of these were made after the engines were built, each component part being formed and pieced together as convenience directed. The foreman at some of these historical jobs was David Elder, father of John Elder, founder of the Fairfield Works. From Napier's many of the earlier battle-ships came, and it was here, too, that Dr. A. C. Kirk perfected the triple-compound marine engine, and made the first set of this type for the navy. The concern is now as briskly carried on as it was in past years by Messrs. John & James Hamilton and a descendant, although not in direct line, of the original stock, Mr. James Napier. In juxtaposition is the yard of the London and Glasgow Co., which has done important government work since taken in charge by Mr. J. W. Shepherd, formerly of Fairfield. On the Clyde, too, Messrs. Caird have done sufficiently heavy work to amply justify dependence upon them in an

TORPEDO-BOAT DESTROYER "WHITING" STEAMING 31.3 KNOTS.
Built by Palmer's Shipbuilding and Iron Co., Ltd., Jarrow-on-Tyne.

emergency, while Messrs. Scott, although their recent naval work has been confined to the construction of engines for dock-yard ships, have also facilities for building cruisers.

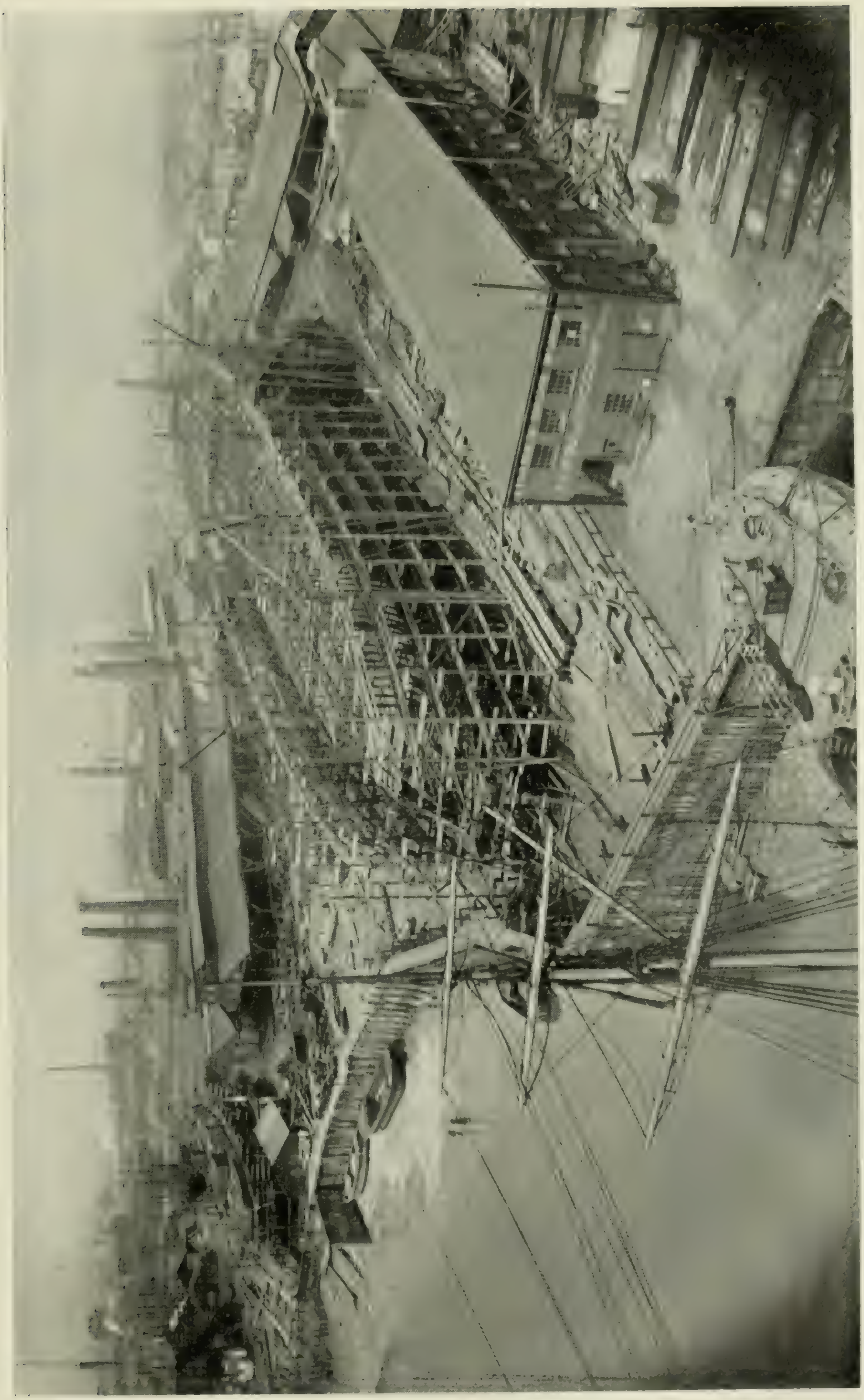
I have spoken of the great decrease in the total money for naval work spent in London ; it would have been still more remarkable, had not the marine engineers of London still held their own against the firms in the north. Humphreys, Maudsleys, and Penn still supply most of the engines for the dock-yard ships ; geographically they have some advantage, for it is but a short journey down the Thames to Chatham and Sheerness, and a comparatively short sea-trip to Portsmouth, Dev-

H. M. S. "PIQUE," READY FOR LAUNCHING.
Built by Palmer's Shipbuilding and Iron Co., Ltd.

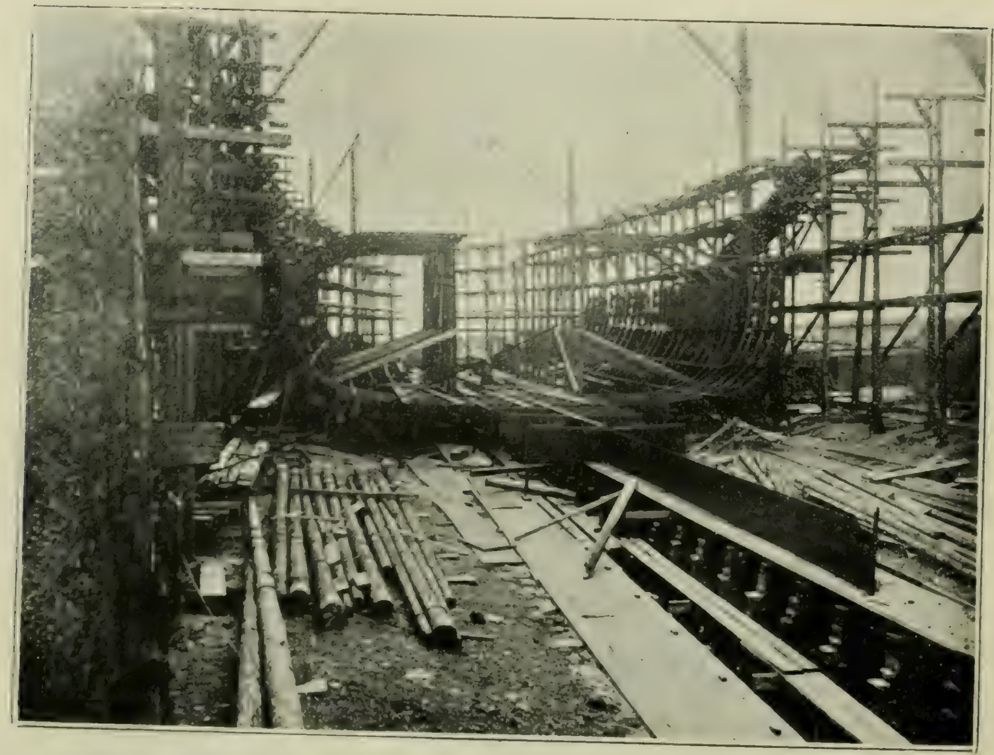
onport, or even Pembroke, while the heavy forgings and castings come from the midlands of England,—a few of them from Scotland,—so that they can be as cheaply sent to London as to the Tyne or the Clyde. Higher wages and rent is the difficulty, and the firms are more and more feeling the pinch of competition. Hawthorn, Leslie & Co., of Newcastle, Scott, of Greenock, and other firms, have undertaken the contract for the engines of several recent dock-yard ships. That London gets most of its money for engines rather than ships could easily be shown. There is a decrease in the number of ship-building firms in the metropolis. I cannot recall a firm engaged in war-ship-work in any district twenty years ago which has not maintained its full vigour to-day, except in London. The Thames Iron Works, where the first British iron-clad—the old "Warrior"—was built, was for a time threatened, but, nurtured by Mr. A. F. Hill with great devotion, it still is an important item in the naval ship-building of Britain. It has a British and a Japanese battle-ship on the stocks, and only recently completed the Fuji for the island kingdom of the east. Samudas, Rennies, Ravenhills, and Millwall Iron Works are only memories.

I. J. B. "SHIKISHIMA" AND H. M. S. "ALBION" AS THEY WILL APPEAR COMPLETED.
Now under construction by the Thames Iron Works and Shipbuilding Co., Ltd., London.

Yarrow and Thornycroft have widened their repute and their influence, if that were possible. The great development in torpedo tactics is traceable to them. The flash of the "Lightning" upon the scene startled European powers to the full possibilities. Since then almost every year has been marked by a forward movement, until now high authorities, like Admiral Colomb, seriously discuss whether or not the whole game of sea-warfare has not been radically changed, and the battleship made as useless as the old galleys of the Roman empire. There is much in it, too. For the price of a battle-ship fifteen or eighteen of these 30-knot destroyers can be built, and they can be manned by the crew of one battle-ship. Such a force attacking a ship, even in broad daylight, would make things lively. I have not recorded on the map the facility for constructing these craft. Twelve yards have laid themselves out for the work of building them, and it must be



BIRDS-EYE VIEW OF THE THAMES IRON WORKS, LONDON.



I. J. B. "SHIKISHIMA" IN COURSE OF CONSTRUCTION AT THE THAMES IRON WORKS.

remembered that, while in all other cases the admiralty submit drawings for hulls, the builders are themselves responsible for design and speed of these craft. Immense difficulties are involved, if there is not some experience to draw upon. Nearly one hundred of these vessels have been, or are being, constructed, and a large number could be built within a year, should the occasion arise. Had this work of building a new type of craft been demanded in any other country, speed premiums would have been almost necessary, but these are unknown in Britain. In the United States, on the other hand, much has been earned in this way. I have taken seventeen vessels at random, and find that the power and speed premiums equalled 7.85 per cent. of the total cost; in one case it was 25 per cent., in others from 10 to 12 per cent. It is all the other way in England; firms compete keenly for government work, for it carries a prestige. The approval of the admiralty experts creates a standard which other governments are ready to accept, and the foreign war-ship built in Britain is none the worse for that.

FUTURE SUPREMACY IN THE IRON MARKETS OF THE WORLD.

By J. Stephen Jeans.

III.—ADVANTAGES IN POINT OF CRUDE MATERIALS.

IT needs no argument, or parade of figures, to make clear the fact that the nation that can produce the cheapest pig iron is likely, all other things being approximately equal, to be able to secure the leading position as a manufacturing country. The production of cheap pig iron involves and implies the production of an ample supply of cheap coal, the command of abundant resources in reasonably cheap iron ore, efficient mechanical equipment, and last, but not least, relatively economical, though not necessarily low-paid, labour. The command of cheap pig iron carries with it the command of cheap materials of construction generally, cheap ships, cheap railways, cheap buildings, cheap tools, and cheap implements of husbandry ; and these, again, mean cheap transport by land and sea, cheap food, cheap dwellings, and the command of material comforts generally at a relatively low price. Of course, it will be understood that I use the word cheap in its ordinary signification of relatively low priced, and that I assume that, apart from a low cost for iron, all of the conditions are approximately equal.

It will be understood, moreover, that all other conditions are not now, and probably, in the nature of things, never can be, quite the same. Accidents count for a great deal in the history and destinies of nations. A recent writer has pointed out that "the accident of position has thrust a relatively insignificant people into the leadership of a world-wide commerce and the government of the world's greatest empire." The location of Great Britain has had much to do, and probably always will have a great deal to do, with her industrial status. But it is now recognized as a fact of much significance that location has ceased to possess dominating importance, and that annihilation of distance by modern inventions may bring up a country of less apparently supreme resources to the level of Great Britain, with its advantages of unique geographical and maritime supremacy.

One of the most striking and perplexing features that are at once presented in any attempt to estimate the comparative economic circumstances of different countries is due to the rapidity with which changes have already occurred, and are now actually occurring, in the industrial world. No one, for example, would have believed it possible, only twenty years ago, that the conditions of our iron and steel industries would in the interval have witnessed the revolution that has actually taken place; that Great Britain would have come to depend on foreign ore-supplies to the extent of nearly one-third of her total consumption; that Germany would have attained, by the accident of the discovery of the basic process, a commanding position in the iron industry of Europe, and would have reached a larger export of finished iron and steel than Great Britain; that steel would have taken the place of wrought iron to the extent that it has; that the open-hearth steel process would largely have displaced the bessemer, and that railway material would have ceased to hold the commanding position that it then did; and that the United States, of all countries, could have produced finished iron and steel as cheaply as they are produced in Great Britain, over a wide area of operations, and more cheaply over a more limited area. Equally incredible would have appeared prophecies at that time as to what would ultimately be achieved in the way of output from a given plant. The man would have been scoffed at who should have spoken of producing 600 tons a day from a single blast furnace; of raising 64-per cent. ore for sixpence a ton; of an output of 100,000 tons of bessemer steel a year from a pair of vessels, or of 15,000 tons a year from a single open-hearth furnace; of an output of 200 tons of wire rods from one mill in a shift of eleven hours; of using pressure of 12 and 15 lbs. of blast; of ninety cent coke delivered to furnaces at little more than a dollar; of labour at blast furnaces being brought down to about 2s. per ton of pig; and of many other matters, equally wonderful and unexpected, that have come to pass during the interval. It is, nevertheless, the fact that to some extent "coming events cast their shadows before," and we may haply succeed in measuring those shadows, and divining their portents, if we take some pains to make ourselves acquainted with the first principles of industrial success and supremacy.

The most remarkable feature of the industrial revolution that has already so largely altered the conditions of manufacturing industry on two continents, and threatens to do so to a still larger extent in the future, is the reduction that has taken place in the cost of transport. Exactly twenty years ago, Lowthian Bell showed that the cost then of transporting to Pittsburg the raw materials required for the production of a ton of pig iron was £1.15.3 ($8.51), while the corresponding cost to Cleveland (Ohio) was £1.16.0 ($8.75); to Lake Champlain, £1.5.6 ($6.20); to the Lehigh Valley, £1.1.2 ($5.15); to Chicago, £2.6.6 ($11.30); and to West Virginia, £0.16.0 ($3.89). These are to-day the leading iron producing districts in the United States, excepting Alabama, where the then cost of assembling the raw materials per ton of pig was 9s. 6d. ($2.31). It need hardly be pointed out that these costs were then much in excess of the corresponding costs in Great Britain. Not only so, but at that time the cost of the materials was relatively very high. Bell gives the then selling price, at the mines, of Lake Superior ore as 15s. to 17s. per ton; of the Cornwall ores as 11s. 6d. to 14s. per ton; and of Alabama ore as 7s. 6d. This old order has now entirely changed, yielding place to new. The low cost at which ores are carried from the various ranges in the Lake Superior region to Pittsburg, Cleveland, and Chicago, is one of the marvels of American economic progress, and hardly less remarkable are the reductions that have taken place in the transport of fuel from the Connellsville coal-field to Chicago and other points of consumption. In continental countries the relative costs of transport are not nearly so low as in the United States, and in Great Britain they are the highest of all, though this fact is largely compensated by the closer proximity of the materials.

One of the most obvious differences in the comparative economic conditions of the United States and Great Britain is that in the former country distances of one thousand miles sometimes separate the ores and the coal, whereas in Great Britain it is difficult to find a position in which the two are separated by one-tenth part of that distance. If the cost of transport in the two cases were approximately the same, this fact alone would, of course, render the competition of the United States impossible; but the average rate charged for railway transport in the United States is not more than one-fourth that charged in Great Britain, and lake transport is generally as low as we are accustomed to in Great Britain for over-sea freights.

In the United Kingdom the conditions under which the pig-iron industry is carried on vary considerably, although there is not the same range of difference between one locality and another that is found in Germany and the United States, owing to the fact that the distances are shorter, there being hardly a single case of either mines or works being more than a hundred miles from the sea. The cost of production nevertheless ranges from 32s. to 48s. per ton. The two most typical districts are Cleveland and West Cumberland, where the approximate costs at the present time, per ton of pig, are as follows:

	Cleveland No. 3.	West Cumberland hematite.
	s. d.	*s. d.*
Iron Ores	14.0	24.0
Coke	13.0	18.0
Labour	2.6	2.6
Limestone and Sundries	2.6	2.6
Totals	32.0	47.0

In this table, the cost of ores is taken at approximately present market values, but it is necessary to keep in mind the fact that, in both cases, the iron ores at any rate are largely owned by, and under the control of, consumers, while in the Cleveland district most of the larger firms own and work their own collieries. The cost of coke given for West Cumberland is that assumed for Durham quality, although coke is made in some cases on the spot, near to the works, and in such cases is cheaper, if inferior in quality. The most serious drawback to the West Cumberland district is that of the high cost of fuel, which has usually to be carried about a hundred miles—more or less—at an average transportation charge of about 7s. per ton, being, I believe, as much as the cost of the railway transport from Connellsville to Chicago, approximately five times that distance. Another serious difficulty in the way of the progress of West Cumberland is the uncertainty that prevails as to the future of the ore-supply. This, as is well known, is the only district in Great Britain that raises considerable quantities of bessemer or hematite ores. The ore is expensive, rarely costing less than 9s. to 10s. at the mine, including royalty, which often amounts to as much as 2s. 6d. per ton. At this figure it compares unfavorably with the ores of Lake Superior, and especially with Mesabi ores, which, as I elsewhere show, are put on the railway for a few pence per ton. So costly, indeed, is the ore of West Cumberland that some of the largest firms in that district, although only a few miles distant from local mines, are introducing ores from Spain, more than a thousand miles distant, on a considerable scale.

There are several secondary districts in Great Britain that are able—for the present, at least—to make pig iron at a relatively low price, including Northampton, Lincolnshire, Notts, and North Staffordshire, which unitedly produce about a million tons of pig per annum from the lias stone. Of late years, however, these districts have made comparatively little progress, whence it may be inferred that they either have not the resources, or lack the encouragement, to extend their output. In some localities, indeed, the iron-ore resources, formerly plentiful, are now becoming rather scarce. Much of the ore supplied in these regions is quarried, and costs from 1s. to 1s. 6d. per ton in cars at the mine. I know of cases where pig iron is produced for 30s. to 31s. per ton, although the fuel has to be transported for relatively considerable distances, up to fifty miles. In some of these districts, raw coal is used in the blast furnaces, which restricts the output, and otherwise imposes limits on the conditions of working. Where this is done, however, plant has in a good many cases—and more especially in Scotland—been provided for recovering the by-products in the smelting process, and, as these are currently valued at 3s. 6d. to 5s. per ton of pig, they materially aid the smelter who faces a low range of prices for his chief product.

Although there is some uncertainty about the failure of the iron-ore supplies of the United Kingdom, suitable for the bessemer pig industry, and although it is probable that British smelters will continue to be largely dependent on foreign ores, there is no cause for despondency; nor does it at present appear probable that any European country, at any rate, will be able to produce pig more cheaply for many years to come. It will naturally be expected that I should justify this view, which I now proceed to do.

No other European country, to begin with, has an equally abundant supply of ores at command, whether native or imported, with equally high-class and cheap supplies of fuel. France, Belgium, and Germany labour under the disadvantage of having, as a rule, to bring the fuel or the ores long distances. France, on the Moselle, where one half of the total pig-iron output is originated, has to pay high prices for fuel, which has to be introduced largely from Belgium or Germany. The principal Belgian works have to transport their ores from long distances, besides having inferior fuel to contend with, and being long distances from the sea. Germany has to contend either with dear ores or dear fuel—dear ores in Westphalia and Silesia, and dear fuel in Lorraine, Luxembourg, and the Saar. Great Britain is scarcely in any case more than thirty miles from the fuel, and, except in South Wales, is in no district even so far as that from indigenous ores. Moreover, the chief British iron-working centres are all on the seaboard,—Cleveland, Scotland, South Wales, West Cumberland, and North-West Lancashire,—while even inland districts, such as Derbyshire, Lincolnshire, Northamptonshire, and Leicestershire, have, in many cases, canal or river navigation at command. This great gain to British iron smelters can readily be appreciated by those who understand anything of the importance of cheap transport, and of a ready command of cheap tonnage for shipping purposes, which Great Britain enjoys to a larger extent than any other nation.

From another point of view, the future of the iron industry in Great Britain is full of hope. No other country has better supplies of fuel, all things considered. It is true that British smelters pay much more for their fuel than is paid in American iron-making centres, as a rule; but I am not aware that there is anything inherent in the circumstances of the case to justify this difference. On the contrary, I have recently, in the *Iron and Coal Trades Review*, taken some pains to point out that, if the British coke industry were to utilise by products and waste gases generally, they would be able to furnish considerably cheaper supplies of coke to iron smelters, and this is a reserve of strength that can always be resorted to in case of need—the more readily as most of the large smelting firms have their own collieries and coking plants. There would be no good reason why pig-iron makers in Cleveland, for example, should pay 12s. to 14s. per ton for coke on which the railway transport is only 2s. 6d. per ton, if the coke-maker took advantage of his opportunities to economise in the process of coke making, and if British smelters were satisfied to accept and use coke from by-product ovens, as is done in Belgium and Germany.

Again, Great Britain, from her geographical and maritime position will always be able to command cheaper foreign ores than any other nation, and the difference in her favour, as against her three leading continental rivals, is not less than 1s. 6d. to 2s. per ton of ore, which means 3s. to 4s. on the ton of pig. Nor is there any good reason why foreign ore-supplies should be so costly as they have recently been. Over a number of years, the average cost of Bilbao ores delivered in England was not more than 10s. 6d. per ton, and to some of the leading firms—such as the Dowlais and Consett Companies, who have their own supplies—it probably has not exceeded 8s. per ton. Some apprehension has been felt as to the future of Britain's foreign ore-supplies. This has not been entirely without foundation, but, from the information with which I have been favoured from various quarters, I am pretty confident that new sources of supply will be made available from time to time, at not materially higher cost than those hitherto paid. Spain possesses many enormous reserves of ore that have hardly been exploited. The Asturias alone, when properly tapped, can furnish abundant supplies for years to come at a relatively low cost. I am myself at this moment interested in mines in that region, whence 66 per cent. hematite ores—the richest hitherto found in Spain—can be mined at not more than 4s. per ton. There may be many similar deposits. I would only add that, if, in the manner I have indicated, the cost of coke should be reduced to, say, only 7s. per ton at furnaces, and the cost of 50 per cent. ore should again be reduced to 10s. at ports,—which in a number of cases means at works,—even Great Britain possibly could produce hematite or bessemer pig for about 30s. per ton, which is probably as low as it will ever be produced in the United States or any other country. At any rate, the reports of my friend, Mr. Swank, of the American Iron and Steel Association, show that the prices of Lake Superior iron ore have not, over a series of years, been relatively cheaper at works in the United States than Spanish ores at works in Great Britain. Until 1894, the high-quality bessemer ores of Lake Superior had never been nominally quoted at less than $4 per ton at lower lake ports, which probably means about 20s. 7d. ($5) per ton at works in Illinois, Ohio, or Pennsylvania, and even if we take these ores as 65 per cent. against 50 per cent. for the ores of Spain, it is clear that, if the bessemer ores of Lake Superior resume their old level, they will be relatively dearer than Spanish ores, representing, in fact, nearly 4d. per unit, at works, against about 2¾d. per unit, for the ores of Spain at British works on the seaboard. I do not, of course, overlook the fact that in special cases American ores are much cheaper than this; but I do not myself believe that so low a price can be continued over any great period of time.

Germany occupies a position of considerable importance in relation to the iron industry, not only statistically, but potentially. She has now reached a production of more than six million tons of pig iron annually, which is only about 2,500,000 tons per annum less than the output of the United Kingdom and the United States in 1896. The greater part of this output is due to Westphalia, where there are 54 heat furnaces, nearly all of them of the most modern description, against 28 in the Siegen district, 27 in Lorraine, 27 in upper Silesia, and 18 in the Saar. Most of the works, however, are of small size. The average number of furnaces to each works in Westphalia is only about 2½; in the Siegen district, 2¼; in upper Silesia, 2¾. In the Saar district, however, there are 18 furnaces for four works, and in Lorraine 27 furnaces for nine works, which is a better record.

There appears to be but little likelihood that Germany will be able to produce pig iron any more cheaply than she has done during recent years. The average price of basic pig iron has fallen from 44s. 6d. per ton to 42s. during the last four years, and forge pig has fallen from about 45s. to 40s. per ton, but these lower figures are extremely unremunerative. It must not be forgotten that about two-thirds of the iron ore mined in Germany is obtained from the Lorraine-Luxembourg district, while more than one-half of the coal and two-thirds of the coke are obtained from the Ruhr district. If better transportation facilities existed between these two districts, their economic circumstances would be greatly improved.

The future of the German iron industry has been already, and is likely in the near future to be still more, affected by the special conditions required to meet the basic process. About one-half of the six million tons of pig iron now annually made in the German empire is produced by this process, which called, until lately, for a minimum of 2½ per cent. of phosphorus. This metalloid was supplied chiefly through tap cinder, which twelve years ago was plentiful at 5s. to 6s. per ton, whereas it is now 16s. to 17s. per ton, and scarce at that. The meaning of this is that tap cinder is no longer obtainable to an adequate extent, and has to be replaced by bog iron ores, which have to be imported largely from Holland and Belgium, at a high cost, although they are extremely variable in composition, and difficult to smelt, making it a matter of great difficulty to produce a uniform iron with these ores. Moreover, these bog ores, like the tap cinder, appear to be within measurable distance of exhaustion. But this is not all. The German works make large use of the ores of Alsace and Luxembourg. These districts unitedly produce more than eight million tons of ore annually, but the quality is not uniformly so good as formerly. The ores now being worked are lower in percentage of iron, which means that they cost more per ton of pig, and they are likely to cost relatively more in the time to come. Besides the phosphoric ores, the German iron smelters import considerable quantities of ore from Sweden, mainly from Grängesberg and Gillivara. The Grängesberg ores contain 60 per cent. of iron, and about 1 per cent. of phosphorus. The Gillivara ores contain 65 to 68 per cent. of iron, and from 0.1 to 1.0 per cent. of phosphorus. Both ores are said to be difficult to smelt, and it will readily be understood that their variable composition, especially in phosphorus, is a further disadvantage. These ores, of course, have to be carried over considerable distances, both by land and sea, so that they are relatively dear—considerably dearer than they would be at English works, which are generally on the seaboard. In the future, it is expected, the German works will need to import large quantities of Swedish ores, although they are not, where used, allowed to form more than one-third of the ore charge, as otherwise the phosphorus limit would be too low; and in any event, it appears, this phosphorus difficulty will throw increased burdens upon the German pig-iron industry, which will have to introduce larger quantities of the minette ores of the Lorraine district, in order to replace the failing supplies of tap cinder, at an increased cost to both the Ruhr and other districts.

In order to show the existing conditions in typical German smelting works, I append the following statement of ores used:

	Price per Ton. *s.*	Yield Per cent.	Charge per Ton of Pig ton.
Tap cinder	16.00	60.00	0.223
Bog ore	9.50	39.31	0.223
Roasted spathic ore	13 50	48.00	0.223
Brown iron ore	12.50	42.00	0.335
Minette ore 40 per cent	9.40	36.00	0.223
Do. 36 per cent	8.56	31.90	0.558
Swedish ores	15.50	61.00	0.446

It will be obvious that the assembling of such a variety of ores over so a wide an area, and the labour involved in mixing and sorting them, must all add to the ultimate cost of the iron produced.

In one respect the German iron industry is certainly as well off as that of any country in Europe. It has a very large supply of excellent coal, which produces a good coke, and, with the general adoption of by-product ovens, this coke can be produced cheaply and sold at a small profit. Whether it is so sold is, of course, quite another matter.* The total quantity of coal left in the German coal fields is calculated as twice the quantity left to the British consumer, but this is not a matter of concern at the moment. The advantage of cheap proximate supplies of fuel is, however, neutralised in all the German coal fields by their distance from suitable supplies of iron ore.

The conditions under which the iron ore of different countries are mined have greatly changed during recent years, but in no country to the same extent as in the United States. In 1877, according to Bell, 1.06 ton per man per day was about the average quantity of ore raised at some Lake Superior mines, and the hewers earned 7s. 1¾d., so that the labour-cost alone must have amounted to this latter figure. Speaking more generally, however, the cost at which the Superior ores could then be put into waggons at the mines was between 6s. 6d. and 8s. 6d. per ton, excluding royalties, whereas to-day ores of similar richness in the Mesabi range can be put into waggons for less than 1s. and in some cases for less than 6d., per ton.

One of the chief causes of this cheapening has been the introduction of improved methods of mining, especially in the comparatively new Gogebic and Mesabi ranges. The mining and shipment of these ores has been fully described in recent issues of THE ENGINEERING MAGAZINE (September and November, 1897). I need only add that no apprehension now exists—as there seems to have existed in 1877—as to the near exhaustion of the iron-ore-supplies of the Superior region ; † and that, as an evidence of how very cheaply iron ores can now be mined in Mesabi, one 60-ton steam shovel has loaded more than 254,000 tons of ore in twenty-five days of ten working hours.

Adopting, with variation of form, the figures given by my friend, Mr. Birkinbine,§ I find the following to be his estimate of the average cost of fuel, ore, limestone, and labour per ton of pig in the leading iron-making districts of the United States three years ago :

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* For some years past, the Westphalian coke syndicate has regulated production and prices.

† Bell stated in 1877 that there was a belief that a million tons annually was the possible limit of the output of Lake Superior ores.

§ Annual Report of the Bureau of Industrial Statistics in Pennsylvania, 1894.

District.	Fuel.	Iron Ores.	Limestone.	Labour.
	s.	s.	s.	s.
Southern States	11/0	10/10	0/6½	3/4½
West Pa	6/8	17/8	1/7	3/6½
East Pa	13/10	20/2½	1/3	3/4
West Pa. (bessemer)	26/0	11/	2/1	3/6½

Mr. Birkinbine gives the cost of supplies, which varies from 30 to 40 cents per ton of pig, but no particulars of royalties, renewals, interest, and other factors. Apart from the last-named items, but including supplies, the figures show that pig iron was then produced in the south at 28s. and in western Pennsylvania at 31s. 2d. per ton. Since then the cost of production has been still further reduced.

I cannot say that I adopt these figures entirely without misgiving. It is difficult, for one thing, to understand why the cost of fuel per ton of pig could possibly be as much as 26s. in one part of western Pennsylvania, and only 6s. 8d. in another. Indeed, it is difficult to comprehend how, anywhere in a State like Pennsylvania, so rich in fuel resources, a ton of coke—which is about the average consumption per ton of pig—could cost so much as 26s., but I rest content with pointing out this apparent discrepancy, and with saying that I attach more importance to the other three cases quoted as being more within the necessarily somewhat limited range of my own observation.

So much has recently appeared in THE ENGINEERING MAGAZINE and other leading American and British publications on the vast changes that have taken place in the industrial situation of the United States within recent years that it is unnecessary to do more here than point out that, so far as present appearances go, cheap transport must always be the dominating factor in that situation. If the rival iron-making countries of Europe had command of equally cheap transport, American competition in Europe, or in any other part of the world, except on the smallest scale, would be impossible. No doubt, the resources of the United States in iron ores are much greater than those of any European country, so far as we know at present.* But it is not so with fuel supplies. There is a proximate limit to the fuel-supplies of the Connellsville coal field, which some recent writers regard as perilously near exhaustion. It is possible that the first check to the progress of the Pennsylvania iron industry, and especially to that of Pittsburg, will come from this quarter. We need not go further apace for the present, since the United States, Great Britain, and Germany are as yet the only countries in the world that make pig iron on a large scale, for both home-consumption and export.

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* I do not speak of Russia, where the resources may be much greater than they have yet been ascertained to be.

AUTOMATIC MACHINERY THE SECRET OF CHEAP PRODUCTION.

By Hiram S. Maxim.

AT the beginning of the last century the relative cost of the necessities and luxuries of life was many times greater than now. Mechanical appliances were of the crudest nature, rapid production was impossible, and wages were low. In the absence of machinery everything had to be made by hand; production was slow and painful, and the hours of labour long. Indeed, it may be truthfully said that at that time man lived by the sweat of his brow. The working classes, which in the very nature of things must always be in the majority, had to content themselves with the bare necessities of existence. Their food and clothing were of the cheapest and crudest nature. Their dwellings were mere hovels, without light or comfort. As so much labour was represented in the cost of production, only very low wages could be paid, and the cost of manufactured articles was so great that the working classes could not be considered purchasers. As a consequence, the purchasing class was extremely limited, being confined to the comparatively rich.

Suppose that a clever mechanic, with no implements or materials other than those which could be obtained at that time, should have attempted to make a bicycle. First it would have been necessary to forge the various parts by hand out of steel. Then, by an extremely slow and laborious process, the tubes must have been bored and turned by hand. The cranks, the chain, the sprocket wheels, the spokes, and all the numerous nuts and screws would also have had to have been made by hand. Certainly from six months to a year of labour would have been represented in a single bicycle. Evidently the sale of such bicycles would have been extremely limited. At the present day a workman can produce at least one hundred bicycles in the time that would have been necessary to the production of one at the beginning of the last century. And what is true of bicycles is true of every other manufactured article. With this great diminution in labour and amazing increase in output, it has been possible to vastly increase the pay of the workingman, so that not only has the cost of the product itself been greatly reduced, but the higher wages paid to the working classes has converted them into a purchasing class, which has increased a thousand-fold the sale of the luxuries of life. Had no improved machinery been introduced, wages would still be extremely low, and the working classes would not be able to enjoy any of the luxuries so common to that class at the present moment.

Two hundred years ago the workingman had to be content with a stone or mud floor. To-day it may be said with truth that the workingmen in America purchase more square miles of carpet in a year than was sold in the whole of Europe during the seventeenth century.

When books were written or engrossed by hand, the amount of labour represented in each book was evidently very great; consequently, they were so expensive and rare as to be practically unknown to the great majority of mankind. To-day, thanks to the improved automatic machinery employed, books can be made with great rapidity and cheapness. The result is that the workingman himself has become a large purchaser.

Suppose any one were to make Winchester rifles by hand; they would cost at least £60 each, and none but an extremely skilful man would be able to make them. The production would be small and the sale very limited, being confined to the comparatively rich. At the present moment, however, by the use of greatly-improved automatic machinery, unskilled workmen and boys are able to produce these rifles with great rapidity and cheapness. Instead of costing £60 each, the actual cost of their production is probably about £1.4s each, and they can be purchased at retail at, say, £3 each. As the sale is not confined to any particular class, it is, as a consequence, very extensive, these rifles being purchased in large numbers throughout the whole world. Without machinery, the rifles would cost £60 each, and would have to be sold for at least £100 each, and perhaps twenty skilled mechanics might supply the demand; but to-day hundreds of skilled mechanics are employed in tool-, gauge-, and machine-making, in order to keep employed some thousands of relatively unskilled mechanics.

A watch in the last century represented a great amount of labour. The market was small, and very few were made, but to-day watches are largely made by automatic machinery, and the cost in labour has been so reduced that their use is not confined to the rich. The working classes, who in the first instance were not purchasers at all, have become by far the largest purchasers, thereby creating a new demand, enabling thousands to be employed in watch-making where only hundreds were employed before.

From the foregoing it will be seen that the great change which has come over the manufacturing industries during the last one hundred and fifty years is due altogether to the improvements in machinery and mechanical appliances. It will also be seen that by the cheapening of production, especially through the decrease of labour required for any particular article, the manufacturer has been able to pay to the working class a much larger wage, and this, together with the cheapening of the product, has converted the working class itself into the most important purchasing class that we have in the market to-day. The whole trend of western civilization is in the direction of rapid and cheap production. Everyone whose eyes are not blinded by trade-union fallacies must see that, the greater the production and the less the labour represented in the article, the greater the market must inevitably be ; production and the market react upon each other.

The artisan classes may roughly be divided into two categories.

First, those who, from their natural ability and surrounding circumstances, have become skilful in the art,—men who, say, in metal working, are able to do the finer kinds of work, such as accurate turning, milling, tool and gauge-making, and, in some cases, designing of new machines or new methods of production. These men receive relatively high pay in all countries, and, by their skill, are able to make tools and machinery and to keep them in order, so that work may be turned out with accuracy and great rapidity.

The second category, which includes about nine-tenths of the whole, consists of the unskilled workers,—men who for the most part are not sufficiently clever to become, or who have not had an opportunity of becoming, skilful mechanics. These men are not able to make, design, or keep in order new machinery or appliances, but, when the machinery is once made, they are able to to turn out accurate work, and one of them can easily take charge of from four to six machines. It is the employment of this class of men at their relatively low rate of pay which enables manufacturers to turn out cheap and accurate work. But it must not be supposed for a moment that the actual pay received by these men—these unskilled workers—is not sufficient to enable them to live in comfort. If a man is intelligent, he may in time become skilful in the use of the machines in his charge, and, if he is very active and works at piece-rates, he may earn as much as a skilled mechanic.

An unskilled mechanic is as much a citizen of the country in which he lives as any one else, and is entitled to the same degree of protection and consideration as is accorded to the skilled mechanic. The skilled mechanic has no right whatsoever to create any artificial system which will restrict the liberty or the facilities of the employer to employ this important class of the community.

In the United States, especially in the New England States, very high salaries are paid to really skilful, able, and active mechanics. As a rule, there is no such thing as a fixed wage, each man being paid in proportion to his skill and his application to business, and every encouragement being given to inventive genius. Any man who can cheapen a process by the designing of new tools, or the improving of old ones, is considered of great value to the manufacturer, and is paid in a degree corresponding to the benefits derived from his ability. In New England, among the higher class of mechanics, it is not so much a question of the production of articles which are actually made to sell as a question of improvement in the machinery which will enable the unskilled worker to produce these articles with great rapidity. The New England manufacturer is alive to the fact that his success depends upon rapidity and consequent cheapness of production, and that this cheapness can be brought about only by the use of automatic machinery which will enable him to employ unskilled labour. He finds it to his interest to pay the skilled mechanic who assists him wages which would be considered very high in any other part of the world. By this system the New England manufacturer, who may pay a skilled mechanic $5 a day, is able to place in the European market many articles of manufacture at prices much below those which prevail in Europe. In England there is a great degree of conservatism, not only among the working people, but also among the manufacturers themselves. When I first came to England, if I went into a factory and saw work being executed on a very old and crude system, and suggested any improvement either to the employer or to the workman, I at once found them very combative. They considered it was necessary to say only that it was the English system.

It is amazing how strongly certain nations are wedded to old ideas. According to their way of thinking, the fact that a thing or a system is old is sufficient evidence of its great value. In Turkey they manage to get along without roads. Their ancestors, thousands of years ago, employed trains of camels and horses for carrying goods and passengers, and why should that not be good enough today? Many are content to scratch the surface of the earth with the root of a tree, when a good plough may be purchased for about 8s., and, notwithstanding that it has been said that the plough is the most useful of all inventions, even the Spaniards still employ a spade for turning over the earth. Bricks are now made in Spain exactly as they were made by the Romans two thousand years ago. The wheels of their agricultural carts are merely large discs of wood, and their oxen, instead of yokes, have a piece of timber lashed to their horns.

All the mechanical and agricultural implements employed in the east and south of Europe are of the roughest and crudest description. When Horace Greeley was travelling in France, he saw an agriculturist cutting his grass with a sickle. He said: "Don't you know, my man, that with a scythe you could cut twice as much grass?" The

Frenchman looked thoughtful for a moment, and replied with great deliberation: "I don't see how that can be possible, because I have not twice as much grass to cut." Where the field of employment is extremely limited, as in this case, there may appear to be some excuse for conservatism, but the manufacturer of to-day cannot afford to be conservative. He finds that many others are already in the world-wide field with the most approved appliances, and, unless he arms himself with the very best instruments that modern civilization can furnish and has complete and unrestricted direction of the men who use these instruments, he will be left far behind in the race. Spain, Portugal, parts of Italy, and the whole of Turkey are extremely conservative. Germany and the United States, on the other hand, are extremely progressive. Numbers of immense workshops are at present being erected in Germany. These are equipped with the finest tools that can be produced—generally of the American type.

In New England the manufacturer is always seeking something new; he cannot afford to use old or imperfect tools. In England the tendency of the manufacturer is never to get a new tool so long as there is anything left of an old one. In New England the manufacturer, as a rule, takes great pride in the cleanliness and order of his shop. He thinks of nothing but his business, and of bringing it to the highest degree of perfection. He has no interests outside his factory. In England, on the contrary, the manufacturer is apt to look on his works only as a necessary evil. As a rule, he takes very little interest in what is going on, does not identify himself with the working people at all, and is always looking forward to the time when he shall retire from business and have nothing more to do with commerce or manufacture. In New England the working mechanic takes great pride in learning his profession thoroughly. He "talks shop" in season and out of season, and, as a rule, has a very extensive and well selected kit of tools. The British mechanic looks upon his trade only as a badge of servitude; he never thinks of his business when he is not obliged to, and, as far as tools are concerned, is often contented with a centre punch and a hammer.

But this relates principally to the majority of English shops of fifteen years ago. I have noticed that the introduction of new American tools and machinery into England, especially those made by Messrs. Pratt & Whitney and Brown & Sharpe, has opened the eyes of many of the manufacturers, and many shops in England at the present moment are being equipped with American tools. This is especially true in bicycle work. Still, there are a great many English factories that would be greatly benefited by a fire, or, in fact, anything that would destroy their old tools.

But the question of tools is not the most serious question that the English manufacturer has to contend with. A very clever Scotchman, who was once the manager of our works, said that the greatest obstacle that he had to contend with was "organized idleness," while the present manager of our gun works, although an engineer of the very highest order, confesses that his duties are more those of a detective than an engineer. Trade unionism has reached a stage of development in England unknown in any other part of the world, and perhaps the most malignant type is that which is found among the metal workers. The union known as the Amalgamated Society of Engineers not only attempts to prevent what they are pleased to call unskilled mechanics from working machines at all, but, if their own men are themselves employed on machines, they resort to every trick and expedient to limit the output. In many cases a lathe may be run a complete day without ever taking a cut at all. They oppose the introduction of new systems or new tools; in fact, all their influence is directed against rapid and cheap production. A large English manufacturer lately said to me that there are more than a hundred different ways in which the employee can cheat the employer.

Shortly before the recent strike and lock-out, finding that the system employed in our wheel works was not only wasteful in labour, but foolish in the extreme, I suggested that certain changes should be made which would save several operations and considerably cheapen the work. The superintendent, however, said he did not dare to make the change; that the wheels must be delivered on a certain date, and that any change which reduced the amount of labour or cost of production would be opposed by the trade union and probably lead to a strike. Even now, he said, I have to handle these fellows with gloves; I have all I can do to keep them at work as it is. He thought it would be best to attempt to get the wheels made in America.

The fact is that the interference of the trade unions is so vexatious and arbitrary that English employers feel disposed to make almost any sacrifice in order to get rid of it, and it appears to me that the only hope lies in the direction of the Federation of the Employers, a society recently formed in England. If the employers can be made to understand that the principal obstacle which prevents England from competing with the other nations of the world in the manufacture of metal articles is trade unionism, and that the only practical way of combating this union is by a counter-combination on their own part, then the time cannot be far distant when trade-union societies will be robbed of their power to do harm; then once more it may be a pleasure to do business in England.

As several of the principal labour leaders of to day are personally known to me, having, in fact, graduated from our own works, where absolutely no unfair treatment or grievance exists or ever has existed, I think I may be allowed to express an opinion on this subject. It is not necessary that there should be an actual grievance in order that the professional agitator may interfere between master and man. The rank and file of trade unions, as a rule, are men who never think. The labour leader is a man with a glib tongue who does not like to work with his hands. He reads the newspapers and a few books, learns to mouth a few big words, and generally commences in a small way. He tells his fellow-workers that they are downtrodden, and little better than slaves; he speaks of the "noble British workman," and caters to their vanity. It might never have occurred before to the workmen that they were receiving any unfair treatment, but the agitator tells them "that the employer is living off their blood." He promises to change all this. If he is a plausible talker, he soon gets a following, and his first attempt is to breed some quarrel between the employer and the employed. Some machinery grievance is trumped up. This may be so extremely foolish that the men themselves cannot be fooled by it. But this does not disconcert the agitator. He drops the subject, and seeks something else. For instance, if he advises the men to strike against piece-work and finds that piece-work is not being done, he makes a demand that the employers shall sign a contract that they will never allow piece-work to be introduced, and this may lead to a strike. The strike, once on, gives the agitator his first opportunity to distinguish himself. He makes speeches; these speeches are reported in the papers, and by degrees he works himself up until he becomes one of the chief agitators of the country.

A great deal has been said about the necessity of harmony between the employers and the employed. There is no question but what this harmony exists in a great many of the American shops, notably those of Pratt & Whitney and Brown & Sharpe. Mr. Pratt once said to me: "It is a pleasure to do business with the kind of men we have in our works. There is a perfect understanding between us, and not the least friction or tendency on the part of the men to take advantage of us."

In Germany, also, there seems to be a complete understanding between the master and the men in regard to cheap and rapid production. The German workman, as a rule, understands that he has the whole world to compete with, and he is willing to meet the master half way in order to capture the work. I remember a case in point. By a mutual understanding between the master and men, a contract was taken at reduced wages, with the result that the work was so cheapened that the master was able to pay full rates at the end of the first year.

In England, on the contrary, it is quite out of the question to come to any mutual understanding of this sort with the workmen. I know one case where a large contract was taken on the basis of existing wages, and no sooner did the men find that the contract had been signed than they struck for an increase. As the contract had been taken with only a small margin of profit, it was found impossible to concede their demands. The work was taken to France. When the strike was ended, there was nothing to do. The Frenchmen got the work, and they have kept it, ever since, and the English works have now been closed for several years.

In order to produce the best results, it is not only necessary that large and airy works should be provided, and that the tools should be of the highest possible character, but that the workmen should have a certain amount of sympathy with the masters. They should understand that their own interest is so identified with the success of the works that it is best to work their machines to the greatest possible advantage. If the workman cannot be made to understand this ; if he attempts to cheat by keeping the tools idle, or by running them slow, or by taking too small a cut,—the whole object of the employment of high-priced automatic tools is defeated. The production becomes slow and expensive, and it will be found impossible to compete with other factories employing the same class of tools where the workmen understand that the interests of the master and their own are identical. If England wishes to compete successfully, and to maintain the position which she ought to occupy as a great manufacturing nation, she will not only have to equip her factories with the latest and best of instruments, but will also have to obtain the earnest coöperation of the men who work these instruments. The antagonism which at the present time exists between master and man is altogether artificial. The great majority of employers treat their men with absolute justice. Unfortunately in many cases, the wages paid are so high as to absorb all the profits, leaving nothing for the master. If the men were left to themselves, they would probably very soon see that it was to their interest to do their best, and look upon their employer as a friend and a benefactor, but, instead of this, the workingman has been taught by the professional agitator that his greatest enemy is his employer. He is made to believe that to be a capitalist is to be a criminal, and that to cheat his master is the only way to get square with him, and he is foolish enough to pay the man who teaches him this folly sufficient to enable him to live without working.

The first strike that we had at our works was due to our refusal to promise that piece-work should never be done on our premises. When our men had been out some months, we succeeded in bringing over from northern Italy, Switzerland, and France some of the best workmen that I have ever seen in Europe. These men wished to work at piece-rates. I asked them how many hours a week they wanted to work. They held a meeting, and decided on seventy-two hours per week. Intimidation having failed to influence the foreigners in the least, the Amalgamated Society attempted to reason with them. They found that it was quite impossible to reason on the question of piece-work, as the foreigners all wished to do piece-work, "because they could earn such a lot of money at it." The Amalgamated Society, however, were not bound to confine themselves to the truth ; so they issued a little circular printed in three languages, assigning quite a different cause for the strike.

I herewith give the French version.

AUX TRAVAILLEURS MECANICIENS !

En présence des tentatives de diminution des salaries et de l'exagération du nombre d'heures de travail imposé, sous peine de renvoi, par la Maison Maxim-Nordenfelt, les ouvriers ont quitté les ateliers et se sont mis en grève.

La maison s'attache maintenant à se procurer des ouvriers étrangers, et a pu ainsi trouver quelques Français qui, dans l'ignorance de la situation, ont accepté du travail.

Dans le but d'arriver à une commune entente sur les diverses mesures à prendre, le comité de la grève a resolu de tenir DIMANCHE PROCHAIN, 2 MARS, 6 HEURES DU SOIR, AU "BEAR AND STAFF," CRAYFORD, UNE ASSEMBLÉE, à laquelle tous les Français devront prendre part.

Il sera donné lecture d'une lettre de l'Union des Ouvriers Mécaniciens du Department de la Seine engageant vivement les grèvistes à résister contre l'odieuse tyrannie dont ils sont menacés par Maxim-Nordenfelt.

On behalf of the Strike Committee,

JAMES HILLYER, Chairman ;
PHILIP DAVIES, Treasurer ;
JOHN BARKER, Secretary ; and
J. H. WATSON, Delegate of the Executive Council of the A. S. E.

From this circular it will be seen that the reason assigned for the strike by the Amalgamated Society of Engineers was not the refusal of the Company to promise never to allow piece-work to be introduced, but "the diminution of wages, the increase in the hours of work imposed under penalty of discharge, and the odious tyranny with which they were threatened by the Maxim-Nordenfelt Company.''

When our foreign workmen found that they could work only fifty-four hours a week, many of them started little shops of their own. Some made electric bells, some toys, others instruments of precision. One came and asked me where he could buy a nice foot-lathe. I asked him what he wanted of it, and he said: ''What can I do? I work only a few hours a day; you won't let me work any longer; what am I to do with the rest of my time? I don't drink; I can't loaf; what shall I do? I must do something to amuse myself? Why not make something to sell?'' Since the eight-hour system has been introduced into the Woolwich Arsenal, it has been found that even Englishmen find the hours too short, so that many of them have started little shops of their own, generally in the bicycle line, and now there is a great wail from local bicycle makers because they are undersold by men who receive a full day's pay for part of a day's work.

It is often said that the Americans compete successfully with English manufacturers on account of the duties, the Americans being allowed to bring their products into England free of duty, while, on the other hand, they demand excessive duties on all imports into their own country. When the United States was a young country, much was said about protecting ''our infant industries.'' It was shown that it was only by shutting out foreign competition that American capitalists and manufacturers could be sufficiently encouraged to commence manufacturing in the United States, but it was not proposed that this protection should be permanent. It appears to me that, when the first ton of steel had been exported to England, there was no further occasion for a protective tariff on steel, at least. When I was a small boy at school, it would have been very convenient for me if I could have had protection from the bigger boys. But, when I became the biggest boy in the school, I needed no protection. So it is with the United States of to-day. No longer the stripling of fifty years ago, the nation has grown into a sturdy manhood; is, in fact, at the present time, ''the biggest boy in the school,'' and requires no protection against the competition of the smaller boys. However, I presume that protection will prevail in the States so long as the glib-tongued politicians are able to deceive the majority of voters by the bug-bear of foreign cheap labour. Foreign labour, as a fact, may be cheaper than in the United States, but the American, as a rule, is able to produce more work for an ounce of gold than any other man on the planet. Why, then, the need of protection?

THE CONTROL AND FIXATION OF SHIFTING SANDS.

By John Gifford.

THAT branch of forestry known as silviculture is merely the application of superior skill and knowledge to the production of wood-crops or other valuable products such as naval stores, cork, oils, waxes, gums, tanning materials, medicinal barks, camphor, and rubber. There has been, and is still, a great deal of nonsensical talk on the subject of forestry throughout the United States, and impractical people who love trees and have no money invested in woodland have senselessly blasphemed the lumbermen. Forestry is little more than scientific lumbering, and forests grow to be cut and utilized. The best system to pursue is the one which pays the best. To-day in forest utilization America equals, considering all things, other nations, and no doubt, in the course of time, when the condition of affairs warrants it, an American forestry system will be evolved out of the present lumbering system.

The true forestry workers of the United States are not endeavoring to curb the lumberman, but to aid him in preventing the reckless destruction of forests by fire. They are mainly striving to secure government aid for the prevention of fires, and the apprehension and proper punishment of those guilty of setting them.

At the same time, however, forestry is something more than scientific lumbering, in that it accomplishes other objects of equal, if not greater, importance. Whenever a forest is planted or preserved for these indirect purposes, the income must be counted in benefits received, not in cash, although a forest may at the same time yield a fair income on the amount invested and accomplish these benefits.

In the region of summer resorts it is profitable to preserve the forest for esthetic purposes, and in that way entice a greater number of tourists and invalids. In prairie regions it pays to plant forests to protect crops and other property from winds. In mountainous and hilly countries it pays to preserve forests for the prevention of erosion, landslides, floods, and avalanches. Where there are farms in valleys, it pays to keep the rough mountain land in forest, because it disintegrates the rocks, and brings to the surface valuable inorganic materials from the deeper layers of soil which gradually wash down the mountain sides and enrich the farmlands below. And it pays to plant forests in certain places for the fixation of shifting sand, which is the subject of this paper.

THE SEA FACE OF THE DUNES ON SEVEN MILE BEACH, NEW JERSEY.

Along the shores of oceans and other large bodies of water, especially in the region of the estuaries of large rivers, there are usually immense masses of shifting sand. It is not within the scope of this article to describe the formation of these sand-banks. It is sufficient to say, therefore, that they usually begin as long sand-bars behind which there are sheets of still water. These shallow bays in the course of time fill up with mud, becoming salt marshes intersected by thoroughfares, salt ponds, and winding creeks. In the meantime the long, flat sand-bars have developed into sea islands, or beaches. When the tide falls, the sand of the shore, ground into powder by the waves, and dried by the sun and wind, is blown in the direction of the prevailing winds, usually inland. The sand moves like snow, until it meets an obstruction, when a dune, or sand-hill, forms, equal in height to the obstacle. A section through a dune shows a beautiful stratification, the sand having been deposited in thin layers, always varying, however, with the nature of the sand, the velocity of the wind, and the obstructions, large or small, which it encounters. These dunes are not hurled bodily by the breezes, but little by little, forming and reforming, forward and backward, changing, in fact, with every caprice of the wind, gentle and almost imperceptible during a light sea breeze, but a stinging, blinding sand-blast in times of gale. In spite, however, of all these minor changes, the sand mass is generally moving, perhaps only a few inches a year, in the direction of prevailing winds. A great deal depends upon the day winds, in that at night the sand is damp and firmer. And so mountains of sand are formed which are often held temporarily by hardy plants which have gained a precarious footing, but which sooner or later, unless watched and fixed, begin to shift, engulfing meadows, farmlands, lakes, bays, inlets, in fact, anything unable to check its course. Very often these dunes are held by a natural growth of plants, and no doubt, when the conditions were different, beautiful forests have grown. In places where these forests have been destroyed the dunes have become restless, and in other instances, where great changes have occurred in the shore line, the forest holding one set of dunes has been, or is being, overwhelmed by those of more recent formation.

There are several instances where lighthouses have been increased in height because of the sand which had engulfed them. In one place on the New Jersey coast I once stumbled upon the corner of an old rail-fence which had been buried and exposed again on the ocean side. It marked the site of an old field. On the North Carolina dunes, chimneys projecting above the sand belong to the houses of an old fishing village. In France and other parts of Europe villages have been buried. At Soulac in Gascony a cross was discovered projecting above the sand. Further investigation showed that it was attached to a steeple, and later a well-preserved church of the thirteenth century was excavated. The church is now in use.

The sand of dunes, although it varies in nature throughout the world, is extremely fine on the eastern coast of America. It beats through cracks in dwellings, frosts the window-glass, and sifts into one's pockets, shoes, clothing, and hair.

On the Pacific coast there are few dunes. In the region of the north of the Columbia in Washington and Oregon there are extensive accumulations of sand, behind which there are bays, as along the Atlantic coast. A part of this area is covered with the beach pine

A DUNE NATURALLY BOUND FOR A TIME BY SAND SEDGE.

(*Pinus contorta*). In this region this tree is low-spreading, with small, faulty trunk and of little timber value, so that the beach groves are not in danger of being sacrificed in a region where there is such an abundance of excellent timber.

There are extensive dunes in the region of the great lakes; especially in Michigan and in Ontario farms are being invaded by moving sand-banks. On the Atlantic coast there is an immense area of shifting sea-sand. These dunes, in all their stages, may be seen to advantage on Cape Cod, the New Jersey coast, and Cape Henlopen. Here and there along the shore excellent bathing-beaches are being damaged, the coast is constantly changing, and in many places valuable harbors are being invaded and inlets choked with sand. In many places what were formerly salt bays filled with oysters and fish are now fresh, stagnant ponds. The truth is briefly this: the sandy coast-line of America, which is at present constantly changing, can be rendered practically stable by the application of forestry and engineering skill. This is worth while, however, only in places where the injury occasioned by the sand warrants it.

A DUNE, HELD FOR A TIME BY A GROWTH OF SHRUBBERY, BEING GRADUALLY SHIFTED BY THE WIND.

The province lands of Cape Cod are a barren stretch of shifting sand-hills. As early as 1826 and 1838 plantings of beach grass were made by the United States government and the town of Provincetown at a cost of $28,000. Since that time more money has been spent. In the meantime, however, the natives have cut the trees and even removed the surface soil, so that the mobile sand began to drift.

Three immense ridges of dunes have formed, which are moving inland toward the town and harbor at the rate of from ten to fifteen feet per annum. The board of harbor and land commissioners, in charge of these lands, has begun to systematically fix these sands by extensive plantings. An immense dune may be seen near Avalon, New Jersey. In its lee there is a luxuriant forest of red cedar, holly, sour-gum, maple, magnolia, hackberry, oak, mulberry, and other trees, with masses of grape-vines and Virginia creepers. It is a picturesque sight from the crest of the dune, which equals the trees in height. The trees, in fact, constitute the obstacle that has formed the dune, which is leading to their destruction. On the land side there is a dense mass of dark-green foliage, beyond which there are green meadows intersected by thoroughfares and bays. On the ocean side there is a mass of sloping sand, out of which project the jagged trunks and branches of smothered trees. The fine sand comes from the great ocean mill, ascends the dune, and falls over its crest in minute cascades. When a stiff breeze is blowing, it skims along the surface and shoots over the crest like a sand-blast, trimming the tops of the trees as flat as though shorn with shears.

RED CEDAR FOREST ON THE BEACH NEAR AVALON, NEW JERSEY.

It is a mistake to suppose that this sand is sterile and unproductive. When mixed with humus, which is abundant in the meadows near by, it is capable of yielding excellent crops. It is not pure silica, being generally mixed with particles of other substances, such as magnetic iron, shells, and mica. Its texture and density are such that there is sufficient capillarity to keep it moist. Beach sand, which appears so barren in a bare and shifting condition, is able to produce a magnificent growth of forest trees in protected positions. The immense oaks and hollies on the Jersey beaches and the beech forest near Scheveningen in Holland attest the ability of the beach sand to support vegetation.

Europe affords the best examples of the complete reclamation of shifting sands, barren heath lands, marsh lands, and other waste places, for the density of population has forced the inhabitants to be less lavish with land and less wasteful of resources than are the people of America.

Extensive dunes have been reclaimed along the Baltic and North seas. At the founding of Copenhagen, for instance, in the eleventh century, the island was clothed with extensive forests. The woodlands passed gradually from the hands of the government to private individuals, and, as is invariably the case, were stripped of trees. The drifting sands of the north shore moved, in the course of two centuries, several miles inland, covering farms and villages. Realizing the danger at last, the people set to work, and now the sands are held in bondage by extensive forests of oak and beech.

In Holland the beaches were guarded, in that they served as natural dikes for the protection of farmlands. The marshland was drained and tilled, creeks became canals, and the dunes, a menace to other countries, served to protect the industrious Dutch from incursions of the North sea. Although the Dutch dunes have always been watched, and have been less mobile than those of other countries, it is only within recent years that systematic dune-planting has been in operation. The government, aided by the Dutch Heath Society, is now actively engaged in forest-planting on all dune land owned by the State.

Much could be said of experiences with dunes in other parts of the world. It is, however, in France, in the department of Gascony, that we find the most striking and valuable object-lesson.

In the early part of this century the condition of the territory, known as the Landes, which is bounded on one side by the rivers Gironde and Garonne, on another side by the river Adour, and on the other by the bay of Biscay, was, in brief, as follows: there were miles of marshy, treeless wastes, covered with a low, but dense, growth. It was damp, unhealthy, stagnant in places, and sparsely inhabited. The few people who lived there depended upon their flocks. There were practically no roads, and communication was so difficult that the people moved from place to place on stilts. The men had little to do but watch their sheep; so they took to knitting, and it is not uncommon even to-day to see a shepherd standing high on stilts, balancing himself with a staff, and placidly knitting socks. Although the country has improved, and is no longer desolate, unproductive, and unhealthy, a few of the people still cling to their stilts; in fact, in several places in the back country the mail-carriers use stilts.

All this region is underlain with a substance called *alios*, which is a sandstone, the cementing material being organic matter and compounds of iron. It forms an impervious hardpan. Canals have been dug, forests planted, and roads—both wagon and rail—constructed, so that the Landes is one of the most prosperous regions in France.

MEADOW BACK OF THE DUNES ON SEVEN MILE BEACH, NEW JERSEY.

The condition of the Landes was directly due to the immense dunes which arrayed themselves in lines along the shore of the bay of Biscay. They moved inland and covered villages, clogging up rivers and inlets. The rain which fell in the Landes was unable to escape into the ocean. It banked up behind the dunes, and flooded large areas. During Roman times these sand masses were wooded and stable, but, in the hands of the French peasants, they were stripped and rendered mobile. The damage done by these moving sands so increased that the government officials studied the work, and devised and executed plans, and now, thanks to de Villers, Chambrelent, and Bremontier, the pioneer workers, the dunes and landes are covered with a beautiful growth of

A TYPICAL NATIVE OF THE LANDES.

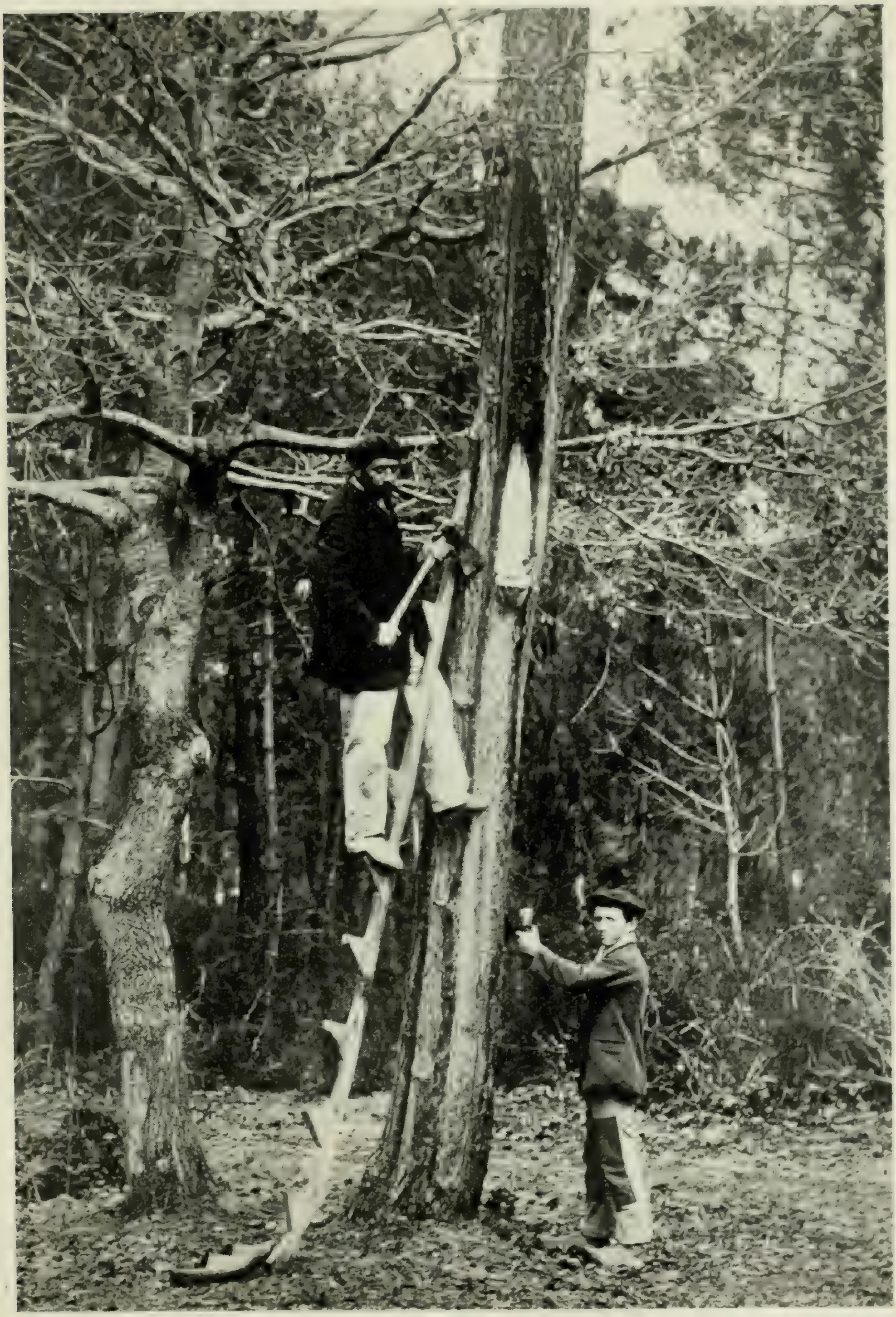
the maritime pine. The region is now a famous health resort, combining the beauties and pleasures of the sea-shore with those of a well-managed pine forest, which extends almost to the edge of the ocean. The manner of reclaiming these dunes is not complex, and, although the result of years of experiment and experience, can be told in general in a few words.

COLLECTING PITCH IN THE FOREST OF LA TESTE, ON THE DUNES NEAR ARCACHON.

A littoral dune was constructed straight along the shore from the mouth of the Gironde to Bayonne. This dune is the secret of all success in the fixation of shifting sand. It is simply a bank of sand of certain dimensions, with a certain slope suited to the condition of affairs. This protective, or littoral, dune is formed as follows: a double fence is constructed of brush, or of palisades driven in the sand. This stops the sand which comes from the ocean. Soon a ridge of sand forms, equal in height to the fence. A double fence is used, as it gives breadth to the dune, and stops the sand which blows through the fence on the ocean side. As soon as a ridge of sand is formed as high as the fence, the old fence is pulled up, or a new one built on top; and so on, until a dune of the height desired is formed artificially. The proper height of a protective dune is 33 feet. It should slope 25° towards the sea, and may be 60° on the land side. The dune must be at least 300 feet from high-water mark. After the dune has reached the proper size, it is kept in shape by the sea marram (*Psamma arenaria*). This peculiar plant, called *gourbet* in France, is exclusively used for fixing the sand on the littoral dune. It has long, much-divided rhizomes, and will grow well only when covered with fresh sand. The dune must always be kept in shape. If sand accumulates in any one spot in undue amount, a draft is formed, which may end in a breach of the littoral dune. *Gardes cantonniers* are stationed along the dune, to watch it closely, and here and there on this long straight sand-bank groups of men and women may be seen digging up the *gourbet* in places where it is too thick, and planting it where needed. Constantly the dune is watched and mended; the forest, villages, and fields in its lee are dependent upon it, and it in turn is dependent upon the humble, but persistent, *gourbet*.

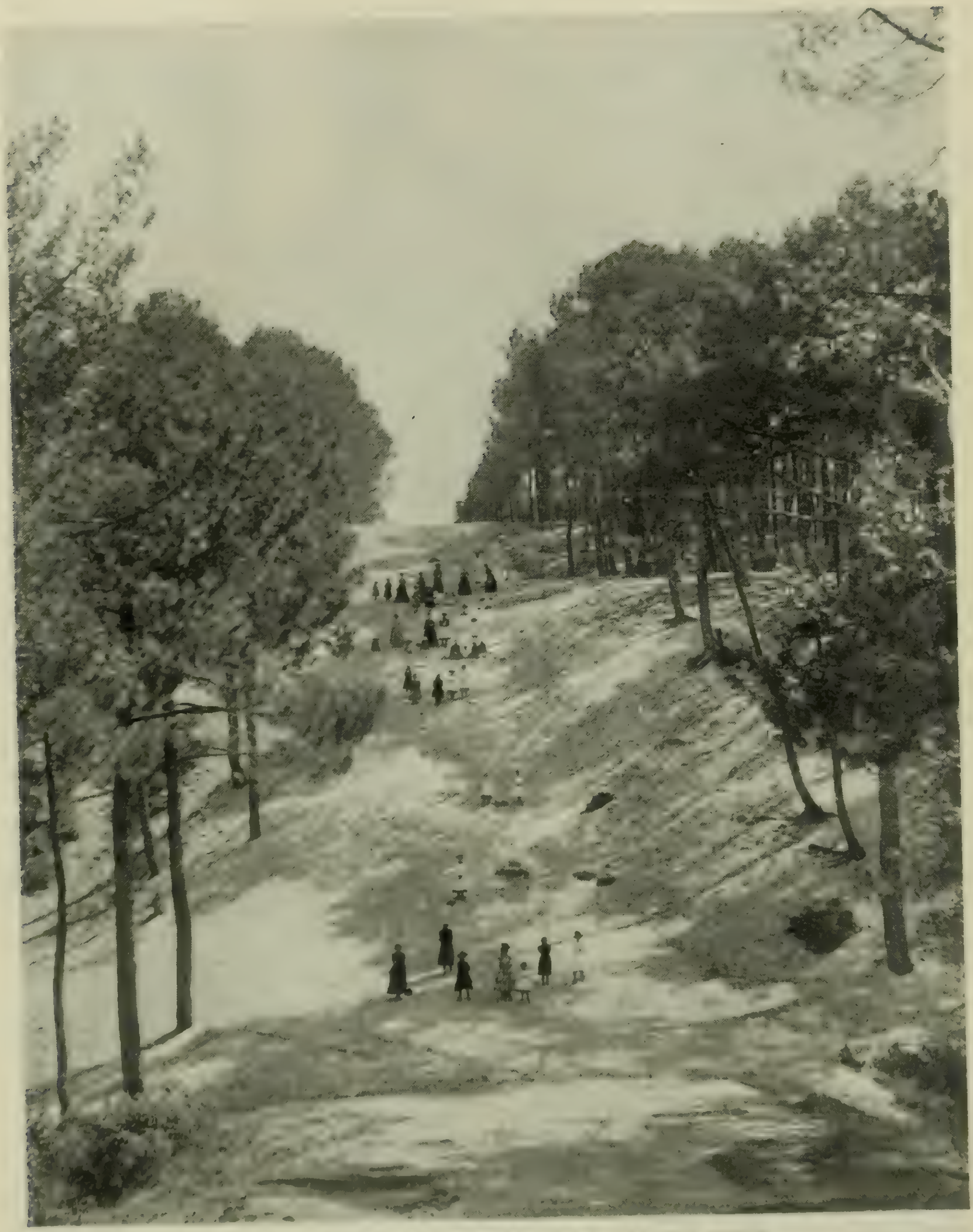
After the formation of the littoral dune comes the work of planting in its lee. The surface of the sand is covered with brush arranged like the slates on a roof, with a shovelful of sand here and there to hold it down. Then the seeds of *Pinus maritima* are sown, with seeds of other plants to shade the young pines, and seeds to attract insectivorous birds. The pines usually come up well, and grow quickly, although close to the littoral dune they are gnarled and stunted by the salt winds. Thus the sands are fixed, and, although the forests do not yield a good interest in cash, they are of incalculable value to a large proportion of the people of Gascony—in fact, indirectly, to the whole of France. Fire lanes have been constructed across the dunes, and, thanks to the watchfulness of the guards and the rigid enforcement of laws, fires are almost impossible.

Very little cutting is done in these forests, the revenue coming mainly from the resin industry. Owing to a lack of roads and in-



METHOD OF COLLECTING PITCH IN THE FOREST NEAR ARCHACHON.

sufficient means of transportation on these dunes, only the most valuable timber is marketed after being tapped for resin. If it is desirable to remove a tree, it is bled to death before being cut. All other



A FIRE LANE (GARDE-FEU) ON LA GRANDE DUNE.

trees are tapped very carefully, and are in no way injured by the process. In fact, bled timber is considered superior to unbled in France. The Hugue method of orcharding is used, a system which does not injure the tree, but gives a resin of better quality and more abundant turpentine. Another article, however, could be written on the French method of turpentine orcharding.

Other industries have started, the people have improved, and the country is more fruitful and beautiful, so that, through the agency of trees, a new province has been practically added to France.

THE ECONOMY AND EFFICIENCY OF THE LARGE GAS ENGINE.

By Dugald Clerk.

IT is not an easy matter to decide what shall be considered a large gas engine. Indeed, when compared with steam engines, it cannot be said that any large gas engines are yet in existence. In one sense the engines are large enough,—too large,—but, in the sense of giving great power, gas engines have not yet reached the really large stage. They are still clumsy and heavy for the power developed, and much improvement is required, considered from a purely mechanical point of view, in order to make them, in this respect, comparable with steam engines.

The gas engine, however, is improving surely, though slowly, and in time to come, no doubt, there will be gas engines as powerful as any steam engines ever built.

Although, in one sense, no gas engine can be considered large, yet existing gas engines are very much more powerful than was at one time believed possible. When the present writer first felt the fascination of the gas-engine problem,—a fascination which, it may incidentally be said, has proved fatal to many inventors,—the largest gas engine in Britain gave about 3 h. p., and this was considered at the time a most remarkable engine; indeed, the noise and vibration caused by its use gave the impression of considerable power, and made engineers feel that, if the engine were made much larger, it would be difficult to design a building strong enough to hold it. This engine was the well-known Otto and Langen, manufactured by Messrs. Crossley, of Manchester, who were then established in a small and unpretentious works, happy in turning out no more than one hundred engines per year of an average power not exceeding 1½ h. p. each.

This was the year 1876, when the old "Shooter" type, or Otto and Langen atmospheric engine, attained its maximum use. There were then practically no other makers of gas engines in Britain. The Lenoir engine had been made for some time at the Reading Iron Works, but it had proved a failure, and only a few were then being built in various small works throughout Britain. The Messrs. Crossley were, for all practical purposes, the makers of the only commercial engine.

Although the Lenoir engine was at this time a commercial failure, yet there were then many examples at work in England, and even so late as 1885 I inspected a Lenoir of ½ h. p. at Petworth, the residence of Lord Lecconsfield, which had been at work for more than twenty years pumping water for domestic purposes. It was in good condition, and had given but little trouble. In the same year I also examined a Hugon engine at the brewery of Messrs. Truman, Hanbury & Co., in London,—also ½ h. p.,—which had been at work there for many years. I knew of another of the same size at work in a druggist's establishment in London.

Figure 1 is an illustration showing the general appearance of a ½-h. p. Lenoir engine about 1866. This was the large gas engine of that day. The engine was double-acting. It drew in a charge of gas and air at atmospheric pressure during the first part of each stroke, and fired that charge by means of the electric spark ; the pressure in the cylinder rose and acted during the latter half of the stroke ; at the end of the stroke the exhaust valve was opened, and the contents were discharged, the same operation being repeated on the other side of the piston.

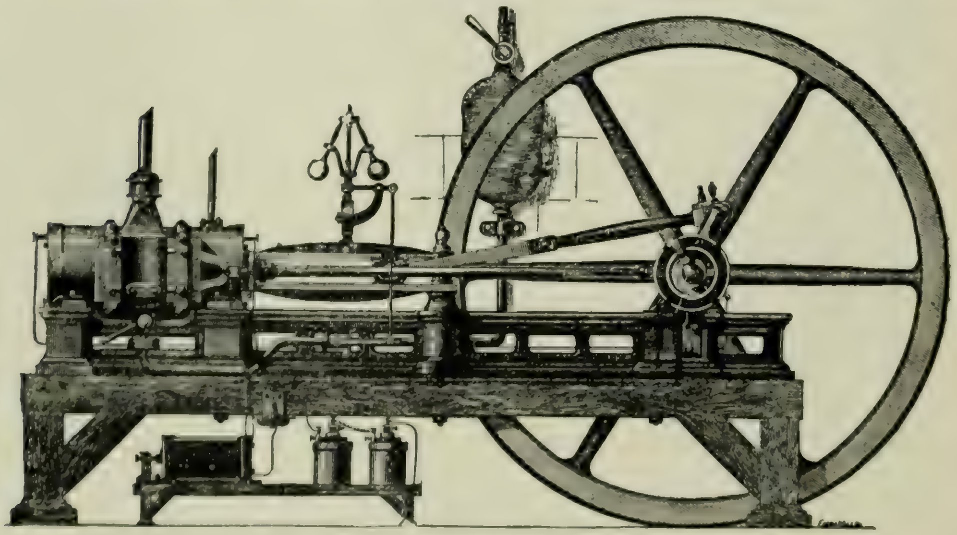


FIG. 1. LENOIR GAS ENGINE.

The illustration just above shows a Bunsen battery and induction coil as then used to produce the electric spark. The governor is shown as of the ordinary steam-engine type, operating a throttle valve placed upon the gas inlet pipe. All the earlier gas engines were governed in this way, as engineers had not discovered that the limits within which gas and air can be mixed and still explode were very narrow. When governing, and running without load, the old Lenoir engine used to throw away about three-quarters of the gas which it used at full power.

Figure 2 is a diagram from a Lenoir engine of 1 h. p., in which the cylinder was 8⅓ inches in diameter, the piston having a stroke of 16¾ inches. The maximum pressure, in this diagram, is 48 pounds absolute, and the average pressure available throughout the stroke was about 8 pounds per square inch. The engine made 50 revolutions per minute, and indicated only 2 h. p. at that speed. This was the large gas engine of 1866, and the result was miserably poor, both as to total power for dimensions and as to economy of gas. The consumption was about one hundred cubic feet of gas per h. p. per hour.

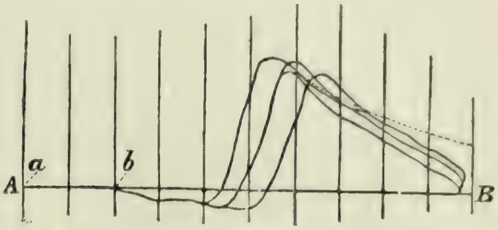


FIG 2. LENOIR ENGINE DIAGRAM.

At the time of the introduction of the Lenoir engine the most extravagant ideas were entertained as to its economy and power. For example, it was stated in Paris, in a journal called *Moigno's Cosmos*, that a 1-h. p. engine consumed 3 cubic meters of coal gas in twelve hours' work,—that is, nearly 106 cubic feet,—the cost for fuel, therefore, being no more than half that required by the steam engine. The actual consumption was much nearer 3 cubic meters per indicated horse per hour, than per twelve hours. The Otto and Langen engine was a great improvement upon this in point of consumption ; it gave a brake h. p. on about 30 cubic feet of gas.

In a 2-h. p. engine tested by me, 2.9 h. p. was indicated, and gas was consumed at the rate of 24.6 cubic feet per indicated horse power hour.

The Otto and Langen engine was the large power engine of 1876, and is shown at Figure 3. This engine consisted of a tall vertical cylinder surrounded by a water jacket. In it worked a piston, which carried a rack instead of a piston rod. The mouth of the cylinder was open to the atmosphere ; across the top of the cylinder was carried the fly-wheel shaft, on which there was a toothed wheel engaging with the teeth of the rack. The wheel ran freely,

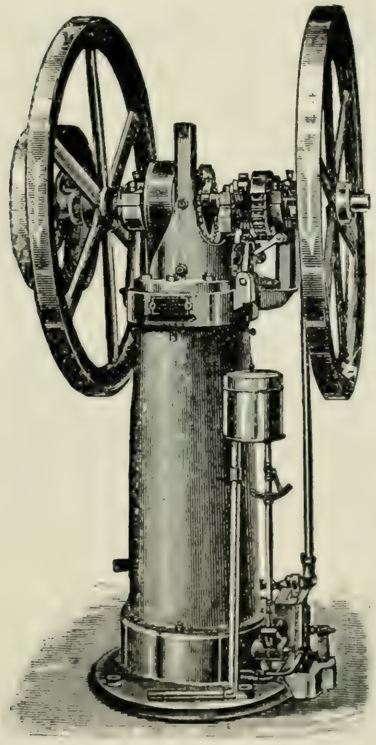


FIG. 3. OTTO AND LANGEN ENGINE.

on the shaft when rotated in one direction, while the piston was on its upward stroke; then, by an ingenious arrangement, it gripped the shaft when the piston made its downward stroke. The shaft, therefore, was free to rotate continuously in one direction, notwithstanding the alternately-opposing movement of the toothed wheel running on it. While the piston moved up, the toothed wheel ran freely in the direction opposed to the movement of the shaft; when the piston moved down, an ingenious clutch arrangement within the toothed wheel came into operation, and caused the wheel to grip the shaft. This enabled the piston to give an impulse to the engine. The action was very peculiar. The piston was shot up in the cylinder by the explosion; the pressure rapidly fell by expansion, and soon reached atmosphere; the piston, however, had been moving rapidly, and had done no work; all the energy developed by the explosion had been given to it as motion, and it therefore moved on, the pressure beneath it falling below atmosphere, until all the energy of motion was absorbed in forming what engine makers have always called a vacuum. The outward flight of the piston then ceased, and the external atmospheric pressure drove the piston back. The actual work, therefore, was done by the atmosphere on the down stroke, and the explosion was spent in obtaining energy in a form conveniently applicable.

I first saw a specimen of this engine—3 h. p.—in a joiner's workshop in Glasgow, in 1876, and was much struck with its ingenuity, and also with the great noise and recoil caused by each explosion.

Steam engineers were then contemptuous of this "atmospheric" engine, as the only commercial gas engine then in use was called. It was, as has been shown, an economical engine for the time,—an enormous improvement on the Lenoir and like engines of earlier date, consuming not more than one-third as much gas for a given power. The whole mechanical arrangement of the engine, its action and balance, was revolting to the mind of the properly-constituted engineer. Successful engines have always been both quiet and simple, and the Otto and Langen was neither. It served its purpose, however, and demonstrated the possibility of obtaining, with some economy, motive power from gas by explosion, and many hundreds were made and used.

The inventor, the late Dr. Otto, of Cologne, was a very ingenious and determined man. Originally a schoolmaster, he became fascinated with the gas engine about 1860, and, being untrammeled by engineering tradition, struck out in the Otto and Langen a successful, though ugly, method of obtaining economy. Throughout the vogue of the atmospheric engine he appeared bent on producing something better, and many of his patents show that he tried varying lines of work, generally failing. In 1876, however, he produced for the first time a successful compression gas engine,—that is, an engine in which the gases to be used were compressed before explosion. This idea was a new one, but to Otto belongs the credit of being the first to clearly see the difficulties to be overcome in carrying out the compression idea, and he originated the present Otto engine or Otto cycle, which has so far proved overwhelmingly the best. This is shown by the fact that, when the Otto patent expired in 1890, practically all the makers of gas engines throughout the world abandoned every other cycle of operation, and adopted the Otto cycle, so that now every gas engine made in Britain operates on the Otto cycle. The expiry of the Otto patent in 1890 had a most important effect on the gas engine from a commercial point of view. So many engineers devoted attention to the engine that the selling price rapidly fell, and now the first cost of engines to the user is only one-half what it was in 1866. This greatly increased the number of small gas engines in use by bringing the cost within the means of many small manufacturers.

It might have been anticipated that the lapse of the Otto patent and the competition among engineers would speedily lead to the production of large gas engines. This was to some extent undoubtedly the case. Larger gas engines are now made than hitherto, but their adoption has proceeded with somewhat disappointing slowness. Difficulties have been encountered in their construction and working which were not obvious to most engineers. A few engineers, no doubt,—the writer included,— *did* foresee many difficulties in the construction of large gas engines on the Otto cycle. These difficulties are now thoroughly well understood, and have been duly met in engines up to about 200 i. h. p. Attempts have been made to build the engines of greater power than this, but, so far as I am aware, these attempts have not been successful. Engines have been made and sent out for powers as high as 400 h. p., but I have been unable to obtain trustworthy details of their performance, and accordingly reserve judgment. I do know, however, from personal experience, that engines indicating 200 h. p. are now practicable and in successful operation.

The first gas engine of the Otto "silent" type, as it was then called, was put upon the market by the Messrs. Crossley in 1878. This engine was 3½ h. p. nominal, 6¾-inch cylinder, 12-inch stroke, 160 revolutions per minute. An engine of this power tested by me at that time gave 4 brake h. p. and consumed about 33 cubic feet of Manchester gas per brake h. p. per hour.

Very speedily larger engines were introduced; at the Kilburn

Royal Agricultural Society's Show, in 1879, Messrs. Crossley exhibited a 16-h. p. gas engine which was much admired by engineers as rather stupendous. Engineers and the engineering journals referred to this engine as the "King of Gas Engines." For several years this was the large gas engine.

No further great increase in size occurred until about 1888, when the hot tube igniter began to displace the old, ingenious, but troublesome, slide-valve flame igniters.

In 1889 a gas engine of 100 i. h. p was exhibited at the Paris exhibition by MM. Delamere-Deboutteville & Malandin, which they called the "Simplex Engine." This engine operated on the Otto cycle, was fired by the electric spark, and was started by a self-starting gear.

From 1889 to the present time, therefore, the advance has been from 100 to 200 i. h. p. Indeed, no great number of large engines have been made.

At the present time the total production of gas engines in Britain reaches about 100 per week,—that is, about 5,000 per year. The average power of these engines is about 20 horse, which makes the aggregate power of gas engines annually manufactured in Britain about 100,000. Of these engines Messrs. Crossley turn out sixty per week. The number of large gas engines, however, at present turned out from British workshops is comparatively small. The largest engines made by the Messrs. Crossley are double-cylinder engines, with opposed pistons acting by their connecting rods on a common crank placed between them. Two engines of this size have been supplied, and have now been at work for four years at the Blackpool Tower Co.'s establishment in Blackpool. These engines have been driving dynamos, pumps, and hoists. They are all 18½-inch cylinder and 24-inch stroke; they use coal gas, and run at 160 revolutions. They indicate 220 h. p. With producer gas, under similar conditions, they indicate 208 h. p.

Figure 4 shows one of these engines, which, as I have said, are the largest yet turned out by Messrs. Crossley. It will be observed that, when working at full power, the impulses succeed each other,—that is, one cylinder drives the crank pin in one direction, and the other cylinder continues the revolution, driving it on the other side of the circle. Then one complete revolution is necessary before any further impulses are obtained. It seems at first sight that, if two Otto cycle cylinders were to be used, the better arrangement would have been that of cylinders placed alongside each other, and acting on the same crank pin, so as to give one impulse for each revolution at full power, leaving only a half revolution without impulse. It has been found in practice, however, that the best engine is produced by giving an impulse in each direction for one revolution, and missing an entire revolution. Such an arrangement provides a less equable application of power to the crank shaft, and requires more fly-wheel power; but it allows of a very convenient form of engine frame, taking up but little width-space, and the Messrs. Crossley have found it most suitable for large powers. In the engine illustrated it will be observed that a rotating centrifugal governor is used, and that this governor is driven from the crank shaft directly, instead of, as in the older Crossley engines, from the valve shaft. This has been found necessary in large engines because of the very considerable torsion of the valve shaft when in operation. A large exhaust valve, say, four or five inches in diameter, even with a pressure of only 40 pounds per square inch above it at the moment of opening, requires a very considerable force to lift it, and this, when transmitted by a lever and roller to the cam on the valve shaft, produces in it a considerable torque. This has the effect of considerably varying the speed of the governor at different points of the revolution of the shaft, and so causes the governor to lag behind, and then suddenly pull off the wheel or knife-edge operating the gas valve. In this way half charges were sometimes given. Half charges of gas and air act very prejudicially in any engine, but are especially objectionable in a large engine, because of the irregular firing and back ignitions produced. The valve gear of the engine is very clearly seen in the illustration. The igniter is of the incandescent-tube type, in which a porcelain tube is used, and the mixture admitted to the tube by a

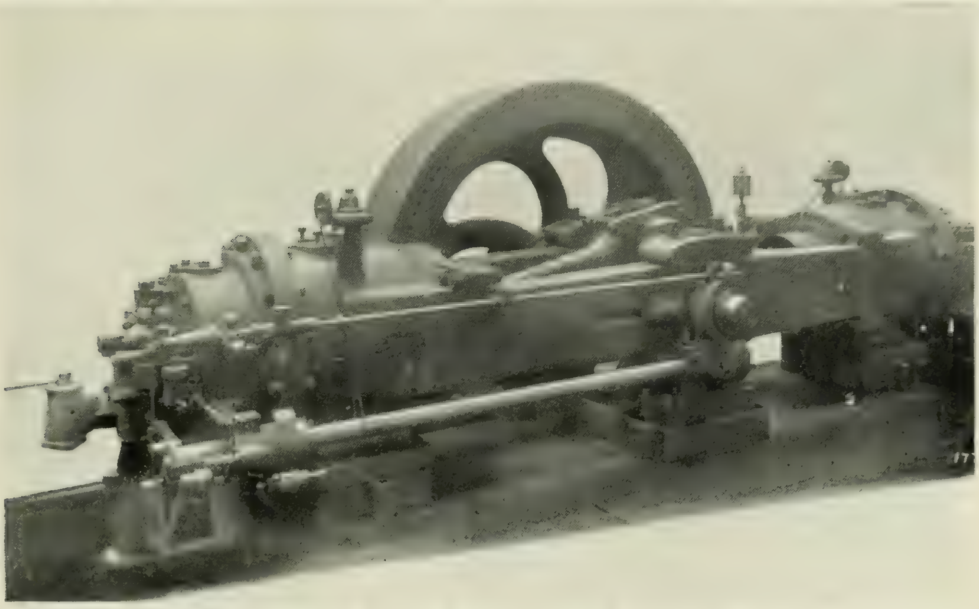


FIG. 4. LARGE DOUBLE-CYLINDER CROSSLEY ENGINE.

timing valve. The engine operates on the usual Otto cycle, and is started by a high-pressure starter used by the Messrs. Crossley under Clerk's patent.

Figure 5 shows a smaller double-cylinder engine of 60 nominal h. p., of Messrs. Crossley's construction, coupled to a Siemens dynamo. This engine indicates 188 h. p. with coal gas, and 165 h. p. with producer gas. The details are practically the same as those described with reference to the larger engine.

Figure 6 shows a 30-h. p. (nominal) electric-light engine, which, running at 230 revolutions, indicates with coal gas 118 h. p., and with producer gas 104 h. p.

Figure 7 shows a single-cylinder Crossley engine connected directly to a centrifugal pump. The engine is one of 40 h. p. (nominal), and gives, when running at 210 revolutions per minute, 120 brake h. p. It will be observed that in this cylinder only one fly-wheel is keyed on the engine crank shaft, the other being carried on the outer end of the pump shaft. The pump shaft and the engine shaft are strongly coupled. This engine is at work pumping out graving dock No. 2, belonging to the river wear commissioners at Sunderland. The speed of the engine and pump can be regulated within a wide range to suit the varying head against which the water is delivered by means of the adjusting screw on the engine governor, and I am informed that at a recent trial the engine emptied the dock in less than the specified time, running at only 180 revolutions per minute. This engine operates with coal gas.

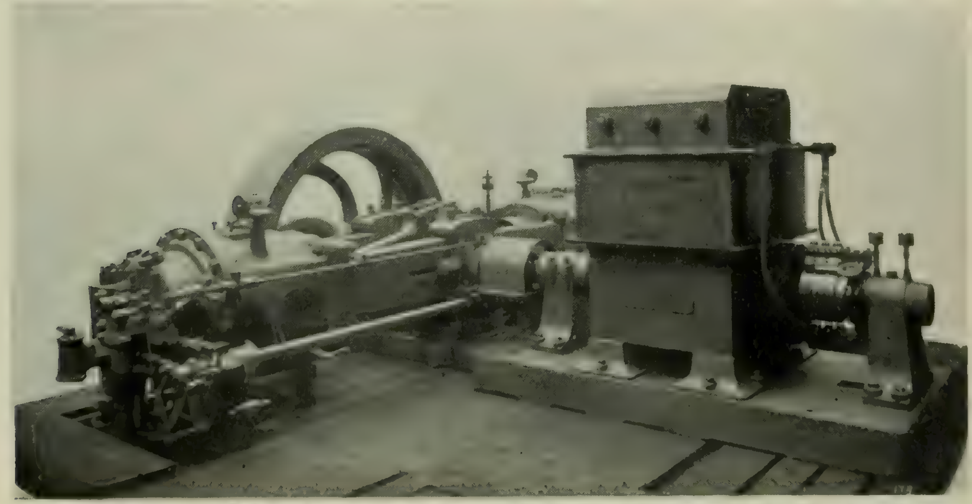


FIG. 5. 60-HORSE-POWER DOUBLE-CYLINDER CROSSLEY ENGINE.

The largest single-cylinder engine built by the Messrs. Crossley is a 50-h. p. (nominal). It indicates 140 h. p. with coal gas, and 130 with producer gas.

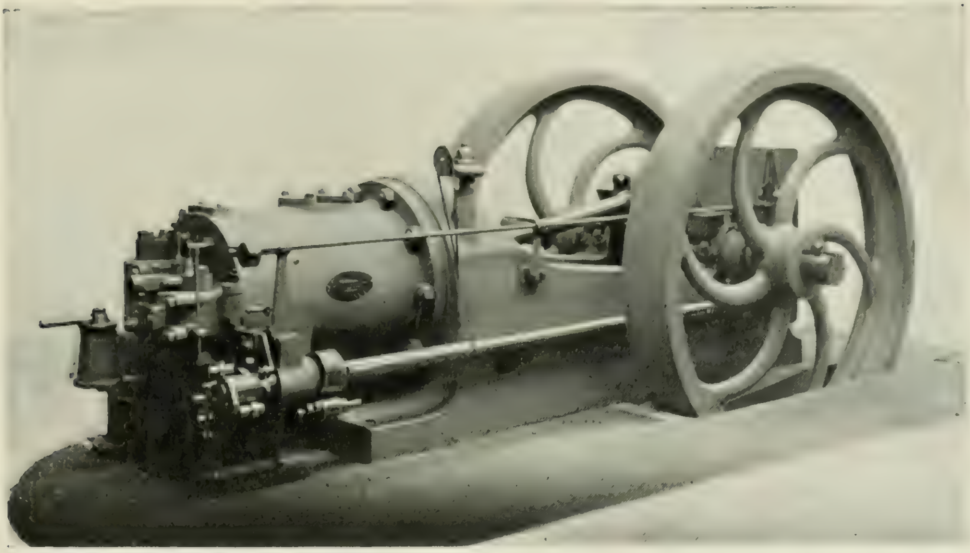


FIG. 6. 30-HORSE-POWER (NOMINAL) ELECTRIC-LIGHT ENGINE.

Altogether, they inform me, the Messrs. Crossley have at work two of the 80-h. p. (nominal) engines, each giving, as I have said, 220 i. h. p., and ten single-cylinder gas engines, each indicating about 140 h. p. Of these engines some have gone to Messrs. Sir John Brown & Co., of Sheffield, The Horsley Iron Co., of Tipton, and R. Cragg & Sons, of Middlesborough. Among the 60-h. p. engines three are in operation for the London county council, pumping water. The Messrs. Crossley thus appear to have delivered about thirty engines which may be called large,—that is, engines of considerably more than 100 i. h. p.

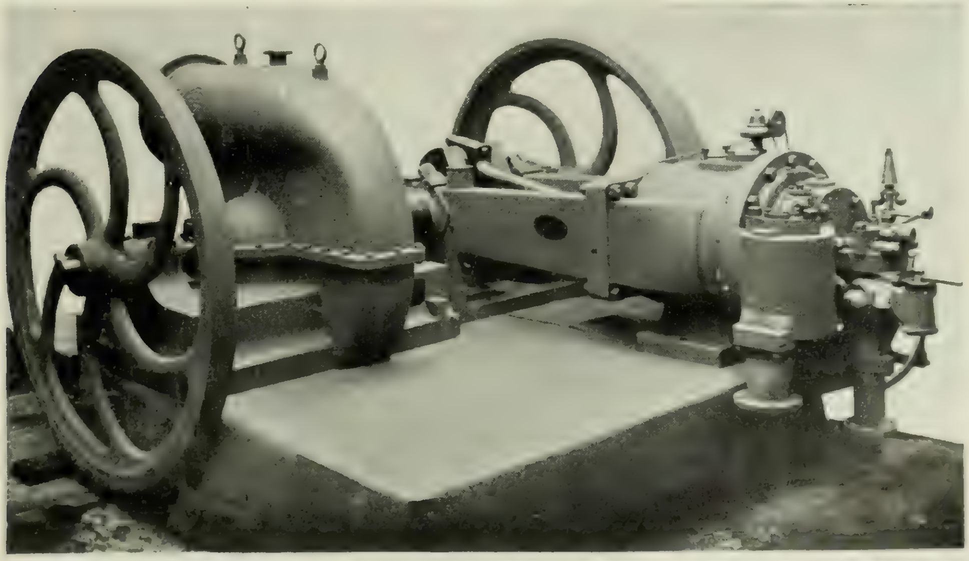


FIG. 7. SINGLE-CYLINDER CROSSLEY ENGINE DIRECT-CONNECTED TO CENTRIFUGAL PUMP.

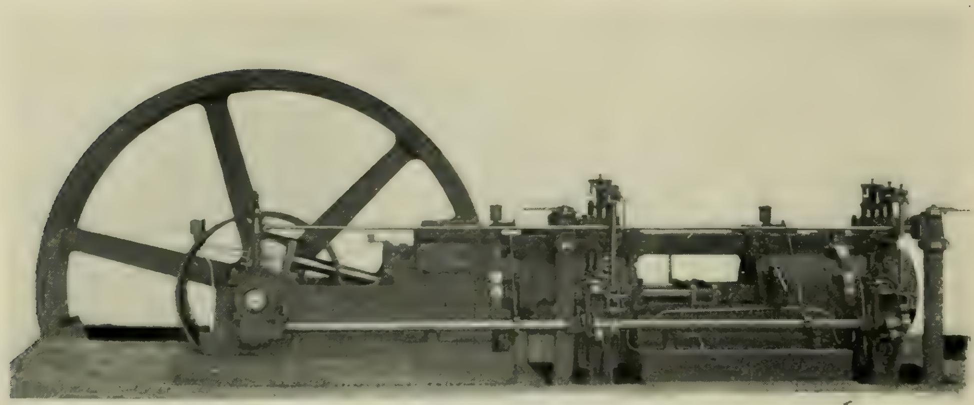


FIG. 8. WELLS BROTHERS' GAS ENGINE.

The Messrs. Tangye also have turned out a considerable number of large gas engines in the sense of the definition adopted herein, that is, engines equalling or exceeding 100 i. h. p., and two of these engines are running in the works of Messrs. Kynoch, of Birmingham, the well-known ammunition manufacturers, operating brass rolling mills for preparing cartridge metal.

This does not, of course, complete the record of progress. Besides the manufacturers whose types have already been illustrated, many other English makers have produced large engines,— Messrs. J.

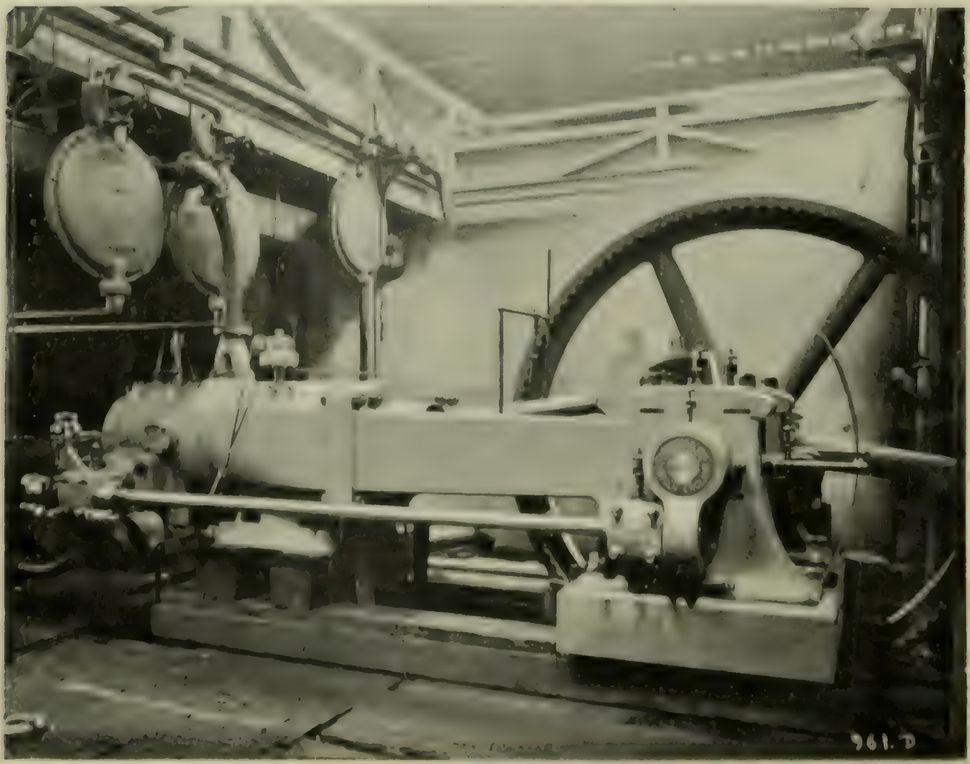


FIG. 9. MESSRS. ROBEY'S LARGE GAS ENGINE.

E. H. Andrew & Co., Dick Kerr & Co., Fielding & Platt, Wells Bros., and Robey & Co.

Figure 8 shows an engine indicating 200 h. p., built by Messrs. Wells Bros. This engine is of the tandem type. Two Otto cycle cylinders are arranged in line. One crank is used, and side rods pass to a crosshead connected to the front piston. These work a crosshead which operates the rear piston. In this engine an impulse is given at each forward stroke. Part of the forward piston is expanded, producing an annular cylinder, which is used as an air pump to supply air for scavenging or discharging the exhaust gases from both cylinders. Messrs. Wells Bros. have turned out three of these engines. They inform me that they have also made several single-cylinder engines, some of them giving more than 100 h. p. Altogether, they have turned out some thirty engines giving more than 50 brake h. p.

The largest engine made by Messrs. Robey gives nearly 100 i. h. p. It is shown in Figure 9. I am informed by Messrs. Robey that one of this size is now at work at Messrs. Luke & Spencers, Ltd., Broadheath, near Manchester, and that it operates on 1¾ pounds of coke per horse power, including the coke burned during the night to keep the producer in form. These engines are the typical large gas engines of the present time.

From this account it will be seen that, as yet, the number of large gas engines in use is small. In my opinion, the total number of gas engines built up to the present in Britain, giving more than 100 i. h. p., is less than one hundred.

Considering the great advantages of these engines over steam engines in respect of economy in fuel-consumption, it is somewhat remarkable that there should be so few; but a closer study of the problem at once reveals the reason. A large gas engine, such as that built by the Messrs. Crossley, called 80 h. p. (nominal), will run at full power on a consumption which may practically be taken as one pound of anthracite fuel per i. h. p. hour. The same engine with a Mond producer would consume only about one pound of common engine slack per i. h. p. hour. This is roughly about one-half the fuel consumed by the best steam engines of equal power, and it seems that in these days of intense competition so enormous an advantage in the fuel bill would speedily displace all steam engines.

So far we have considered the early types of gas engines, and reviewed the progress up to the present time. In a second article, which will appear in the February issue of THE ENGINEERING MAGAZINE, I shall consider the leading difficulties in the problem as they now present themselves, with a view to aiding engineers in their solution.

COST-KEEPING METHODS IN MACHINE-SHOP AND FOUNDRY.

By Henry Roland.

IV.—PROBLEMS OF GENERAL EXPENSE AND FIXING OF SELLING PRICES.

HAVING, in the preceding papers of this series, detailed some attempts at prime-cost reduction, the subject of total cost, or selling or "estimate" prices, follows in natural sequence.

Every machine builder not operating under a patent or the rare condition of some special production carrying so high a reputation in connection with the shop name as to deter competition must sell in the open market at prices very little above those of his rivals. If a builder, say, of steam engines or heavy lathes has an inquiry from a possible customer, he is perfectly aware that every other well-known builder of such work is in receipt of the same letter, and that, to have the order finally filled at his own establishment, he must quote a price not very much above what other makers of equal reputation will offer. He therefore desires to fix a price as close as possible to a fair living advance on the actual cost of the tool to himself or to his establishment, and, if the price is to be named with any degree of certainty, he must first know the probable total cost of the machine, this probable cost being made up of the prime-cost augmented by the proper share of the general expense with which this particular unit of production may be justly chargeable.

Salaries of non-producers, rent, taxes, interest, depreciation of plant, advertising, travelling, and collection of accounts go to make up a very large total expense account, some part of which will be directly chargeable to the production on which a price is to be fixed. What shall that proportion be, and what are the causes and conditions which determine the share of the expense account with which this particular article is justly chargeable?

Reference to relations of prime-cost and expense for a series of years shows that these relations are subject to large variations; in the busy years the volume of the prime-cost account is greater in proportion to the expense, and in dull years it is less. Perhaps in a good year the prime-cost total will greatly exceed the expense total, while in a dull year, with the same class of work, the expense total will largely exceed the prime-cost total, and the percentage of expense to be justly added to each dollar of prime-cost will vary accordingly.

It thus becomes clear that the actual future cost of a machine can never be known. The probable prime-cost can be determined with an approach to accuracy, but the expense percentage which this prime-cost total should carry is always a matter of assumption, and can be based only on the past.

In most cases, it is safe to say, it is an assumption pure and simple, based on previous assumptions the accuracy of which has never been fully determined; and, when it is known that one concern may add as little as 30 per cent. to the prime-cost and assume the total to represent the total cost of its product, while another may make the increment as much as 150 per cent., it is at once apparent that between such extremes there lies a wide field, any portion of which may be occupied by erroneous prime-cost figures.

In point of fact, no manufacturer or constructer can ever know the exact cost of any single article of his own production, because the cost factors include so many variables that in no two instances is the cost of two similar pieces or machines exactly the same. Fortunately it is not essential to business success that precise first cost of the selling product of a metal-working establishment should be known in every individual instance. Business existence and success is, like every other existence in this world, a matter of averages, and it is enough for the foundation of a thoroughly systematic conduct of shop matters that the manager should have a fairly correct approximation to the average cost of his product. Again, it is probable that no machine builder ever knows the exact cost of any machine he makes, because an attempt at precision would entail an expense far beyond its possible gain.

The obtaining of exact foundry costs is, on the face of things, more difficult than the fixing of machine-finishing costs, as the foundry cost involves a multitude of obscure factors, or elements which can be made to appear obscure to some minds. Hence, perhaps, has come the quite erroneous practice in some establishments of charging all foundry labor directly to expense, laborers and moulders alike, assuming that the moulder's labor is so small an item as to be neglected without detriment to practical accuracy. So slipshod a method does not preserve sufficient detail of expenditure to enable the formation of estimates of such accuracy as is required in competing bids for work. The prime-cost and total cost of castings should be estimated by the method used for machine work.

The general problem of total-cost estimating is perfectly simple when the prime-cost and expense totals are known, because the whole expense must be added to the respective prime-costs, so that the sum of the total costs shall equal the sum of the prime-costs and the expense. Simple as this procedure seems, it can be complicated in many ways, and may even be viewed in such lights as to leave certain large items of the expense account out of the total-cost estimates.

In point, total-cost estimates, as made by several large and carefully-regulated establishments, do not include interest on the value of the plant. This is a most unwarrantable omission. If the plant were rented, the rent would undoubtedly be included in the expense account and duly distributed as a part of the total cost of the machines built. Again, if the plant were sold, and its value in cash loaned, the lender would expect to receive interest on the amount, as a matter of course. Viewing the shop or plant as an individual entity transacting business for itself, the case is the same; the plant carries an indebtedness to some one, equal to its cash value, present or original. This indebtedness is necessitated by the creation of the plant, and interest on this amount is certainly a part of the general expense account, so long as the indebtedness exists. This indebtedness can be cancelled only by the earnings of the shop above total expenses. Profits of operating the plant might be credited to the shop, until this indebtedness and interest were cancelled and the original investors in the concern had their money back again. In this case the shop would own itself and be in debt to no one, and the interest charge would rightly disappear from the general expense account, but, until this establishment-cost is liquidated in some way, the interest charge in the expense account is certainly legitimate.

At the Pond shops it is maintained that the cost of plant is an investment, a gambling stake made by the founders of the establishment and so owing nothing to anybody. These premises are correct; the cost of a metal-working plant is a venture on the chances of business fluctuations, and is often totally lost; but it is not clear how this condition of risk extinguishes the inherent earning power of the capital invested,and, if the shop cannot pay interest on its cost, then this interest must remain a charge against an insolvent debtor.

At the Sellers establishment interest on the value of the plant is charged into the general expense. At the Brown & Sharpe shops it is not so charged. The Brown & Sharpe plant is valuable, having about six and one-half acres of floors on eleven or twelve acres of ground near the business center of Providence, Rhode Island, the buildings costing perhaps $2.50 per square foot of floor surface, and the tool equipment being very large and costly. In one cabinet on the Brown & Sharpe gear-cutting floor there are about nine thousand dollars' worth of gear-tooth mills for shop use, and the plant throughout is furnished in a commensurate manner.

Obviously, if an interest charge on the value of this magnificent plant were added to the general expense, it would make a material difference in the percentage added to prime cost to obtain the total cost ; and the same is true of the Pond shops, where the buildings and tools are excellent.

At the De La Val shops the cost per square foot of floor is only about seventy-five cents, while at the fine steam-engine shops of Mackintosh & Seymour, Auburn, New York, the square foot of floor costs only about half a dollar ; it is manifestly absurd to say that such differences should not be recognied in the total-cost estimates.

Strange as it may appear, there is also a difference in American shops over the question of depreciation of buildings and machine-tools. The Pond practice ignores plant depreciation, saying that their buildings and tools are thoroughly well kept up, and are to-day in every way as valuable productive factors as they ever were, and that, since the up-keep goes into the general expense, no other charge can justly be made. At the Brown & Sharpe shops a depreciation charge is made of 2½ per cent. on buildings and 5 per cent. on tools. There is also a material difference in the practice of various shops as to the inclusion of machine-tool deterioration in the expense account. Suppose the Brown & Sharpe figure of 5 per cent. is accepted as correctly representing the first year's loss of value on a machine tool costing $1,000, the tool will have a value on the inventory of $950 at the beginning of the second year. Then comes a question as to whether the depreciation for the second year shall be $50, or shall be 5 per cent. of the second-year value, $950, making the decrease in value only $47.50. This difference is material ; as in the first case the whole value of the tool is extinguished in twenty years, while in the second case the tool would continue to appear as an asset forever, with a value constantly decreasing, but never lost.

In point of fact, it appears that machine-tool effectiveness does not decrease where the up-keep is as thorough as it certainly is in, say, the Pond, Sellers, and Brown & Sharpe shops, these being all machine-tool-building establishments. But there is always the advance of the art to consider ; a machine tool may be as good to-day as it ever was, and yet stand so far behind the most recent tools of the same class in efficiency that it cannot be used at all by an economical manager, and hence has no shop value whatever, though it may still be so good as to find a ready purchaser at a considerable price. It is evident that, in this view of the case, the value of standard machine tools is constantly decreasing, and that such a charge for depreciation should be made yearly as will, when added to the price obtainable for the tool at a second-hand sale, equal the original price, with interest, to the day the well-kept-up antiquated tool goes out of the shop to be replaced by a more efficient modern creation.

Tools and fixtures, when made for a special job, are usually charged to the job as expense on that particular work, unless paid for by the customer under special contract. In some shops these special tools and fixtures are carried on the inventory as assets, but this is wrong, except in unusual cases. An old English law gave the English shop the ownership of all special tools and fixtures, even though designed and paid for by the customer. There may be such a law in the United States, but there it is the invariable practice to regard all special tools for which the customer pays as his property, of which he may take possession at will. An expensive lot of special tools held by the shop would be pretty sure to control future orders for the same job, and, under the probability of future orders, special tools and fixtures might become very valuable assets, as ensuring future profitable contracts. American practice generally charges all special tools and fixtures to the job for which they were made.

In the foundry, standard patterns well kept up are an asset, all repairs being charged to expense, and an interest charge on original pattern cost going to the expense account. Flasks go to the expense account, and can be carried on the inventory only at nominal figures.

These special items of the expense account are referred to as showing different ideas of cost keepers, and indicating the errors through which certain systems of total-cost keeping can be made to show a total production cost so low that at selling rates the shop should be making large profits while, in fact, it is continually losing money,—an error which can easily lead to underselling rivals until unexpected bankruptcy winds up affairs.

It seems very clear that every penny which has been or is being expended in or for any part of a machine shop or any other manufacturing business must represent a credit to some individual or account, and an equal indebtedness to some other individual or account, and can never be properly neglected until returned from some source to the original owner, because, in ordinary business, nothing except payment can extinguish a debt. If this assumption is correct, then the total original cost of the shop and the ground used by the shop is an interest-bearing debt, and the interest thereupon is an item of expense. The gain in ground value, if any, is an asset, and is sometimes, in the case of American shop properties, so great as to extinguish the whole debt for the plant in a few years; but, until the business is closed and the realty is sold and paid for, an interest charge on the realty value must go to the expense account, and until the realty value and interest thereupon are paid out of the profits of the business, there can be no just credit on the shop books for the advance. The shop takes all, and must pay all before it can make a profit.

This seems an incontrovertible proposition; yet many large establishments deny its truth, thus making their total cost estimates fall below what they actually should be. It is but natural that a manager should wish to think himself as good a manager as his rivals, and hence able to sell his product as cheaply as others can sell theirs, and hence, perhaps, comes the fixing of expense-percentage additions to prime-cost such as will permit selling prices to meet the market.

On the face of things a high percentage of expense addition to flat cost seems to indicate extravagant management, while a low expense percentage looks like economical management; but management may not be the deciding factor in the case. For example, at the Providence Steam Engine Works the expense percentage is 75 per cent. of prime-cost or under, while at the Newton Milling Machine Works, Philadelphia, the expense addition is 15 per cent. on cost of material and 150 per cent. on labor-cost. On this bare statement it appears that work is conducted very economically by the Providence Steam Engine Company and very poorly by the Newton. The facts are that the Providence shop makes nothing but steam engines of standard construction, and has small or no travelling or advertising expenses, and only a very small force of non-productive labor, while the Newton builds largely on special orders requiring new drawings and pattern-making in each case, thus making each machine an individual construction and inevitably increasing the cost enormously.

Another point in dispute is the addition of an expense percentage to the cost of materials purchased from the outside. In some places this is not done; in other places it is done, the managers asserting that interest on cost from the date of payment, storage on the shop premises, inspection and handling, and inevitable losses through breakages and imperfections, fully justify such an addition to the purchase and freight costs, which is undoubtedly correct.

To sum up, the expense account should include all salaries and wages except such as appear on the producer's time cards and go to make up the prime-cost, including a fair recompense for the services of the owners themselves, interest on first cost of entire plant (realty and all), depreciation on buildings and tools, and, where the warerooms or selling offices are separate from the shops, all items of expenditure due to such separation. In estimating, a percentage on materials purchased should be added, and, in brief, every possible outlay should be considered. Then, if the establishment makes a low price because it wants work for its men or wants to keep work from going to rivals, the manager at least knows what he is about, and can correctly estimate his losses from the first. It often happens that work is taken below living rates, because the manager, having the choice of two evils, accepts that which in his judgment involves the lesser detriment to himself and his establishment; but in this disastrous practice it is essential that he should not underestimate the damage to result from his policy.

As an exhibition of actual practice, the following estimate of founding costs is taken from the form of the Builder's Iron Foundry, which has always made large amounts of castings for sale:

1. Estimate fully time cost of core-makers, moulders, and helpers.
2. Estimate fully cost of pig iron piled in the yard, adding for waste 9.13 per cent.
3. Examine melting book to determine average cost per gross ton for the last four weeks; to this average cost add 34.2 per cent., which will make a total equal to the cost of melting each net ton, covering waste and remeltings.
4. For cartages add 88 cents per short ton.
5. Moulding materials equal 36.13 per cent. of producer's wages.
6. Foundry labor, $3.75 per ton.
7. Yard expenses, cleaning and shipping, $3.50 per ton.
8. Fixed charges. These will vary with number of producers,—*viz.*, moulders, moulder's helpers, and core-makers. The number of these men on the time book is taken as the base, as the average output per same number of producer's names is almost constant.

With 100 names in work, on order under estimate add for fixed charges 50 per cent. of total producer's wages.

For 90 names add 55.5 per cent.
" 80 " " 62.5 per cent.
" 70 " " 71.5 per cent.
" 60 " " 83.33 per cent.
" 50 " " 100 per cent.
" 40 " " 125 per cent., and
" 30 " " 166 per cent.

As the Builder's Iron Foundry pays great attention to turning out heavy loam work, these figures are worthy of especial attention from a commercial point of view, or, in other words, may be regarded as giving direct information of commercial value to other firms in the same line. Some other establishments refused their actual addition percentages on this very ground that the giving of these percentages would be of assistance to their competitors, while in the same breath lamenting the want of correct knowledges which led those competitors to often fix selling price below living rates. All American manufacturers of metal work who were seen in this connection were emphatic in their statements that it would be of great benefit to all concerned if correct information were supplied, leading to the fixing of correct total-cost and selling-estimate figures; but some refused the disclosure of their own percentages.

In general terms, the larger the force of hands working, the smaller the percentage of expense to be charged against the labor of each. Thus the percentages at the Builder's Iron Foundry range from 50 per cent. when one hundred moulders are at work to 166 per cent. for the minimum number of thirty hands.

So, again, the dividing of a shop into a great number of different departments increases the expense, although in certain cases this increased expense is more than returned in increased production.

The Yale & Towne Foundry costs are very accurately kept by use of a form which details the piece-cost as well as the weight-cost. This form is given below, and, as shown by the column headings, it enables a detailed tabulation to be made of the prime-cost of each article.

THE YALE & TOWNE MFG. CO.

COST OF IRON CASTINGS.

Date.	List No.	Article.	Per Flask.			Rates.	
			No.	Lbs.	Oz	Molding per Flask.	Core-Making.
......	......	....	.....	......	......	....	....
......	......	....	.....	......	......	....	....

LABOR COST PER LB.						COST PER LB. OF	
Molding.	Core-Making.	Melting.	Finishing.	Annealing.	Total.	Metal Melted.	Material, Molding, Anl'g and Fin'g
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....

PERCENTAGE.		COST PER LB.	WEIGHT OF ARTICLE.	CASTING COST PER PC.
For General Expenses.	For Bad Castings.			
....	....	....	....	....
....	....	....	....	....

Account is taken of the minor details of moulding, recognizing the great difference in cost between castings having little weight per flask and those which enable a considerable weight of metal to be poured in each. The moulding per flask and the core-making are piece-rates, and the melting, finishing, and annealing are percentages. Examination of some of these Yale & Towne castings-cost sheets convinced the writer that they exhibit a very close approach to accuracy in cost per pound and piece. The actual percentages used in calculating those items not obtained from time- and piece-work records could not be obtained of the Yale & Towne shops for publication, and would not be of value if they were printed, since they would not agree with the practice of other American shops, and certainly no other shop seeking such details of cost would assume the Yale & Towne percentages for their own. With the same number of hands in work and the same grade of product and standard of inspection, the prime cost of castings is surprisingly uniform in different shops. But, if the standard of inspection is raised, the cost of product must increase out of all proportion, seemingly, to the increase in rigidity of inspection.

This is true both of finishing and founding. In a recent case two sixty-inch lathes were built together, one with ordinary accuracy, and the other with a small inspection limit, the latter costing twice as much for labor as the ordinary commercial tool.

This increase of cost seems almost incredible, but it was in this case the unpleasant fact, and estimates must take notice of any specifications calling for unusual accuracy of construction in machine work, or an uncommonly fine surface in castings, owing to the enormous increase in total cost which is thereby certain to accrue. Thus in the Yale & Towne shops iron castings which, so far as size, weight, and stock were concerned, could be contracted for outside at 3 or 3½ cents were costing 6 and 7 cents in their own foundry, simply because of the fine skin and entire freedom from imperfection demanded.

EUROPEAN SYSTEMS OF HOUSE-HEATING.

By J. L. Saunders.

HOUSE-HEATING practice in Great Britain, when compared with that current in America, exhibits great differences in style of apparatus employed, in the systems in favour, and in the extent to which the development itself has proceeded.

Some of the reasons, at least, are very apparent. In a large portion of the United States and throughout Canada, the winter climate is such that some artificial heat, over and above that obtainable from an open fire, is absolutely necessary; in Great Britain, however, the old-fashioned open fire-place is, as a rule, sufficient, or, at least, has been so considered until very recently. Within the last few years there has been a growing appreciation, among the British people, of the comfort and advantage of maintaining an even temperature throughout an entire building, whether this be a dwelling or a school, church, office-building, or other *quasi*-public edifice. Indeed, even in private dwellings, where it is most attractive and most nearly adequate, the open fire, if depended on entirely, too often gives one the choice between being partly roasted, if he sits near, or shivering, if he moves to the further corners of the room or passes to the halls and staircases.

While the severity of the American climate has been of itself sufficient to cause the great demand for heating apparatus, there is at least a general belief that the climatic effect on the human system creates a greater dependence on artificial warmth among Americans than among Englishmen. The blood seems to become thinner. It was my own experience that, when I first went to America, I could well endure the cold, and the temperature of 70° usually maintained in buildings there was far too warm for me. As years went by, I grew more and more sensitive to the cold, and, on first returning to England, I felt the temperature of 60° maintained in English houses quite too low; but in a short time I became re-acclimated.

Again, the large blocks of buildings erected in America demand efficient adaptation of the heating apparatus, for it would be almost an impossibility to heat these large buildings (no matter what their use) by open fires. Fancy the large coal-storage space that would be necessary, and the work and labour of carrying coal to and ashes from all the different rooms, and of cleaning and attending to all these fires; the cost would be tremendous. In fact, one of the strongest economic principles in America is labour-saving; and an efficient heating apparatus is a labour-saver as well as a money-saver.

By a natural retroaction, the general introduction of improved house-heating systems, which primarily stimulated manufacturers to increased effort toward the production of efficient and economical apparatus, has itself received an impetus from the lowered cost and increased convenience of the many devices now offered in the market.

There is no doubt that America is now far in advance of Great Britain, in its systems of heating apparatus, and the materials and methods used in their installation. Many years ago the mode of heating was as crude in America as, I am sorry to say, it often is now in Great Britain; but, as time went on and the demands became greater, natural competition proved to be, as always, the greatest producer of improvements; every keen competitor was anxious to have the latest device, style, system, or material, to assist him in obtaining a contract. For example, the hot-water or low-pressure steam boilers generally employed in America are, as a rule, far in advance of those in general use in Great Britain. This great advance has come about within the last fifteen or twenty years.

One of the principal points for which the manufacturers have striven was to produce a boiler that would give the maximum amount of heat for the minimum consumption of fuel, the cost of fuel being a great consideration in America. And as every manufacturer was anxious to produce the best boiler, it is natural that the questions of grate-surface, fire-surface, and rating of a boiler should have been carefully studied in America. Other points receiving especial attention have been the manner of constructing the surfaces in the boiler so that they will absorb the utmost of the heat of the gases before they pass into the chimney; simplicity of construction; easiness of erection; getting them into the building required to be heated; cheapness and simplicity of repairs; and facilities for firing and keeping clean. From the combined results of all this study the modern American boiler has been developed. In Great Britain all these important factors in the construction of a boiler seem, as a rule, to be but little studied. The average English boiler seems to be constructed with but little consideration for the amount of fuel it will consume, and its grate and heating surfaces seem to be proportioned, not according to any set rules or ratios, but purely by guesswork. Many a boiler manufacturer of Great Britain, if asked the size of the grate-surface or fire-surface of his boiler, or its rating in proportion to its grate- and fire-surfaces, would look in astonishment, and ask the purpose of the question. In many cases, indeed, he could not tell. With but very few exceptions, the boilers made in Great Britain are of wrought iron, either welded or riveted, and are made in one piece, requiring to be brick-set. Almost invariably this setting is done according to the individual idea of each heating engineer or heating contractor. The boiler manufacturer does not have any particular design for setting the boiler bought from him. Thus it may be seen how vague are the statements of the rating of a boiler, as this depends a good deal on how it is set.

Nearly all the manufacturers make the same style of boiler, the only difference being that each has his own name. The only competition is in price. But within the last few years some manufacturers have begun to produce and push patent boilers of their own, using as strong arguments for their special type its advantages in construction, style, and heating-power in comparison to fuel-consumption. A few years will no doubt witness vast improvements in the boilers for heating systems in Great Britain. Most of the new boilers put on the market at present are of the American style, and do not require to be brick-set; they are called independent boilers, but they are made of wrought iron.

The British people are somewhat prejudiced against the cast-iron boiler, for just what reason it is hard to tell ; no doubt one reason is that cast-iron boilers so far produced in Britain have been cast in one piece, have been very heavy because of the thickness of metal, and may easily be broken because of unevenness of expansion and contraction, as well as unevenness of thickness. It is asserted, also, that if a boiler is of wrought-iron made in one piece, there is less likelihood of leakage than in a cast-iron sectional boiler which has to be put together with many joints. This is a point open to discussion. Although there is this prejudice in England against cast-iron boilers, it is no doubt dying ; I have used a number of American cast-iron boilers in recent contracts, and several firms are using and selling American cast-iron sectional boilers in Great Britain today. In fact, there is one English firm that is putting on the English market a cast-iron boiler of American manufacture, though sold under another name. Although the larger number of boilers in use in Great Britain are of wrought iron, either brick-set or independent, both classes show great variety in type, style, and mode of construction—especially in the arrangement of flues, cross tubes, and narrow flues. The greatest objection to the independent boiler is that, as a rule, it has no covering, and therefore is giving out a great deal of its heat where it should not. Indeed, the commonest fault with British boilers is that they are great fuel-consumers.

The low-pressure hot-water system is the one most largely used in Great Britain, but its chief application is to the heating of schools, churches, and public buildings; very few residences are heated in any way except by the open fire-place, although of late years far more of the owners of large residences and mansions are putting in some one of the newer heating devices, using it, as a rule, as an auxiliary to the open grate, which holds its own because it ministers to the natural love of the sight of an open fire and the maintenance of good ventilation. Low-pressure steam is but little used, as it is often considered to give too high a temperature for the heating of buildings. Another reason may be that its installation is not well understood, some very bad results having been produced. The two-pipe system is used, and the principal trouble has been that the returns have not been properly taken care of, with the result that water hammer has run riot. The one-pipe system is but little known, and the British architect is rather a difficult person to convert to new ideas. There are a few firms in Great Britain which are now doing considerable steam-heating, using one-pipe work ; and very good work indeed they are doing, for there is no question that, when the Briton goes in for good work, he does the very best. The fan system (or plenum, as it called in Great Britain) has only of late come into use, and only in large public buildings, but it bids fair to become prominent. It is installed in Great Britain in a manner somewhat different from that prevailing in America ; more often than not low-pressure hot water is the heating agent, instead of steam. Instead, however, of making one large heating chamber, from which the warmed air is blown through tubes to the upright flues and thence to the different apartments in the building, the heating surface is subdivided, and the small units placed at the foot of each individual flue, and cased in. A brick tunnel leads from the fan around the building (under the ground floor), and from this tunnel the air is supplied to each stack of heating surface and regulated at the bottom of the separate flues. There are, of course, many ways of installing the fan system and of regulating the supply of warm fresh air and of taking out the foul air. Where low-pressure hot water is the heating power, a gas engine is used to draw the fan.

The high-pressure hot water system (known as the Perkins system) was at one time very largely used in Great Britain, but of late is less often installed. In this system the boiler is simply a coil constructed of very heavy wrought iron pipe and incased in brick work. From this coil are run strong inch pipes with $5/8$ inch or $7/8$-inch bore. The circuit is generally continuous, with no valves and no means of shutting off any part of the apparatus ; the heat must be either on or off for the entire building. In some cases, however, there are several circuits with valves and bye-passes to each circuit. The pipes are put together in a very strong manner, for they have to withstand a heavy pressure. The joints are connected by right- and left hand couplings. The joint is not made by tightening on the threads. The ends of the pipes are made one convex and the other concave, and the process of tightening the couplings butts the two ends of the pipe together. The same kind of joint is made with all fittings, and the fittings are all made of wrought pipe of heavy gauge; where bends (or elbows) are required, the pipe has to be bent by the use of a fire. The system is run at a very high temperature, and, as it is entirely sealed up with but a small air-chamber or air cushion, the pressure is very great. The principal objection is the unevenness of temperature, caused in the following way. When the fire is on, the water does not circulate slowly, as in a low-pressure system, but stands still until a high temperature is reached, and then goes through the pipes with a rush ; as soon as the fire drops, the circulation stops,and the heat soon dies down.

The use of hot-air heating in Great Britain is very small ; in fact, about the only system used is the Grundy, and that principally in churches and schools. It is different from the practice in America, which commonly involves the use of a furnace with tin flues.

The systems of low-pressure hot-water heating in use are much the same in both countries, the three principal being the rising system, the drop system, and the one-pipe system. In the first, the flow and return are duplicates one of the other, and the mains run side by side, or one above the other, in the basement cellar or in trenches below the ground floor, branches rising from these mains. In the drop system, a main riser is taken to the highest point of the building, and a main run around the top of the building, and from this main are taken drop pipes which supply the heating surface on their way down, the flow and return to the coil, or radiator, being from the one drop pipe ; then all the different drop pipes are gathered into a main return pipe below the ground-floor and returned to the boiler. The one-pipe system consists of one large main, in basement or cellar, which main is of the same size throughout. Its highest point is at its exit from the boiler, and it has a gradual fall all the way till it enters the return. This one pipe is used for both flow and return, the flow branches leaving the top and the return branches entering at its side.

Although the systems are much the same in both countries, they vary in detail ; all three systems have been more fully developed in America. The rising system is most frequently used in Great Britain, the other two systems named being less often met, although I have put in several since my return to England. As to style of work, America is far in advance, but the large demand for heating and the great competition account for the superior quality of American work. The demand for heating systems has been comparatively small in

Great Britain, as the country has been satisfied to go on in its old lines; but, as the demand increases, improvements are made, and some very fine systems are now being erected. Indirect heating, for example, which until very recently was hardly known, has been introduced in several large and handsome residences, the work being of the very best class. The indirect stacks are incased in chambers constructed of the finest glazed bricks, so arranged that access can be had for cleaning. The registers are of solid bronze metal of Tuttle & Bailey's best manufacture. Several strong principles which have been allowed to govern the erection of heating plants in Great Britain have prevented the work from presenting the most pleasing effect. One of the most prominent is the prevailing use of cast-iron pipe, heavy and clumsy in appearance; it has to be adopted in many cases for the reason that the water is so bad that it destroys or fills up the wrought-iron pipes in a very short time. This has limited the demand for wrought-iron pipe, especially in sizes more than two inches in diameter; and, as a natural result, the prices of all the larger sizes are very high. No doubt to an American a very peculiar appearance would be presented by a heating job wherein the mains were of cast-iron pipe in lengths of nine feet, with spigot and socket joints caulked together with either rust joint, or red and white lead and spun yarn; nevertheless a great part of the work in Great Britain is done in this manner; again much of the heating surface is constructed of coils made of cast-iron pipe, two inches and upwards in diameter, put together in the manner described above. In greenhouse work cast-iron pipe is always used, and, as a rule, the joints are made with india-rubber rings, known as india-rubber expansion joints. Another point affecting heating plants in Great Britain is that comparatively few of the buildings have basements under the whole house; this makes it very difficult to get in mains, and the result is that the mains are made as short as possible, and the different rooms are heated by running long coils from room to room, making long circuits with short mains, to avoid very heavy expense in making channels, trenches, or tunnels below the ground-floor. At one time there were but few radiators in use in Great Britain, the heating surface being usually of cast-iron pipe and cast-iron coils; but now the public is beginning to desire them and architects to specify them. But the Briton has little desire for decoration. It is generally his request that the radiators be put out of sight as much as possible. There is no doubt that the heating business in Great Britain is improving very much, and that the class of work is growing better every year and patterning more after American practice; but no doubt it will be some time before buildings are heated throughout, and each room controlled by a thermostat.

THE TRANSMISSION OF POWER BY BELTS AND PULLEYS.

By C. L. Redfield.

THE tendency to seek after "some new thing," which is at least as old as literature and as strong in the department of mechanics as elsewhere, is perhaps in part responsible for the neglect into which the older methods of power-transmission have recently shown a tendency to fall.

Electrical, or, in proper situations, pneumatic, transmission exhibits so striking convenience and so marked economy that there is a not unnatural disposition to concentrate attention upon these methods, and to slight correspondingly the older means of belts and pulleys.

But these older and more peculiarly mechanical contrivances are by no means superseded; they must be largely employed even in connection with the newer agencies, and in a vast number of establishments will continue to be the sole dependence. Part, at least, of the disfavor with which they are sometimes regarded arises from the very unfair method of judging a system by its abuses.

Comparison of the several rival systems is too often made in forgetfulness of the fact that, in delivering power through belts, pulleys, and shafting, there are many elements to be taken into consideration. First, there is the diameter of the shaft, depending upon the power to be delivered and the revolutions per minute; second, the diameter and face of pulleys, depending upon the revolutions and belt-speed required or assumed; third, size of belt depending upon the force that must be delivered at the speed assumed. In ordinary cases these elements may be properly combined in an endless variety of ways, each of which would reach the required result, but with differing degrees of loss from friction. Any person who has had experience in a shop considers himself qualified to arrange pulleys and shafting so as to deliver any required power, but comparatively few know how to do so with a minimum of loss.

Before any rational effort can be made to reduce the losses in transmitting power through these elements, it is necessary to know where they occur and what causes them. They occur in the belts at the points where they bend around the pulleys, and in the journals of the shafts.

The first loss consists of the power required to bend and unbend the belts as they pass on and off the pulleys. While the loss at this point is relatively small as compared to that occurring at the other, it is not altogether insignificant, as will be seen by the fact that it is continually going on at four places on each belt in use. Furthermore, reduction of loss of this kind is worth considering, because it costs nothing, and is all gain, not being accompanied by any attendant loss. To transmit a given amount of power, a certain number of cubic inches of belting must pass a given point in a given time. This may be accomplished by moving a large sectional area at a slow speed, or a small area at a high speed. In either case (or in any case) the product of the area multiplied by the velocity must not be less than a certain fixed quantity, the size of which depends upon the power to be transmitted. With the velocity fixed and the sectional area ascertained, we can obtain that area from either a thick and narrow belt or a thin and wide one. The force required to bend any body varies as the breadth, as the square of the thickness, and as the amount of the bend. For example, a belt two inches wide will offer twice as much resistance as another of the same thickness and only one inch wide, and a belt a quarter of an inch thick will offer four times the resistance of another only an eighth of an inch thick. Combining these two, we find that a one inch belt a quarter of an inch thick is twice as stiff as a two-inch belt an eighth of an inch thick. As these two belts have the same sectional area and are consequently equal, it follows that less power (one-half) will be lost by running the thin belt instead of the thick one. As the loss also depends upon the amount of the bend,—that is, upon its sharpness,—and as the sharpness of the bend depends upon the diameter of the pulleys, it follows that pulleys of large diameter are more economical than those of small diameter. It is seen, therefore, that, as far as the belts themselves are concerned, the maximum of economy is obtained by the use of thin belts on large pulleys.

There is still another advantage in the use of thin belts and pulleys of large diameter, which, while somewhat vague and incapable of valuation, is none the less real. A thin belt, by virtue of its pliability, hugs the face of the pulley more closely than a thick and stiff one, and consequently will not slip so easily under a given load. To prevent any belt from slipping, it must have a certain tension on the slack side, the subtraction of which from that on the tight side leaves a remainder that represents the force transmitted. The sum of these two tensions represents the pressure thrown upon the journals of each of the two shafts connected by a belt, and it is this pressure that forms one of the elements of the loss at those points. For each pound of tension added to the slack side of a belt to keep it from slipping another must be added to the tight side to overcome it, which two pounds, transmitted to the shafts, gives four pounds on the journals. It therefore follows that, for every pound removed from the slack side of a belt by reason of superior belt-adhesion, four pounds of pressure are removed from the friction surface at the journals. Pliability of belt and large pulley-diameter both tend to increase this adhesion, and thus to reduce the loss at points distant from themselves. For the same reason wooden pulleys are superior to iron ones, and leather-lagged pulleys, in turn, are superior to wooden ones.

The amount of power that can be delivered through a shaft varies as the cube of the diameter and as the revolutions per minute. Thus a two-inch shaft will transmit eight times as much power as a one-inch shaft at any given speed, and a given shaft will transmit twice as much power at two hundred revolutions per minute as it will at one hundred.

The loss from friction varies as the weight, load, or pressure on the journals, multiplied by the speed. Considering the shaft by itself, its friction-speed varies as the diameter, and its weight as the square of the diameter; consequently the loss from friction varies as the cube of the diameter. It is apparent, therefore, that, if the shaft carries no load but its own weight, it makes no difference what size is used, provided the speed corresponds to the size. In any shaft carrying a constant load other than its own weight, every change toward smaller diameter and greater number of revolutions increases the speed of the rubbing surface faster than the total weight on the journals diminishes, and there is consequently a loss; changing in the opposite direction will effect a saving. Usually the load varies when the speed varies, and in such cases the question of gain or loss depends upon whether the product of the load multiplied by the speed of the journal-friction is an increasing or a diminishing quantity.

A horse power is 33,000 foot-pounds, which is a force in pounds multiplied by the number of feet through which that force must move in one minute to produce one horse power. Thus, if the force is 100 pounds, it must move 330 feet per minute to make the product of the two equal to 33,000. Consequently, the faster a belt travels, the less pull it must exert to transmit a given amount of power. As several times this pull (whatever it may be) rests directly upon the journals of the shaft and becomes part of the load it carries, it is evident that high belt-speed is a potent factor in reducing loss by friction. The speed of belts may be increased either by increasing the revolutions of the shaft, or by enlarging the diameters of the pulleys, or by both.

It may be stated as a general truth that every increase of belt-speed serves to lessen the loss of power through friction; but, as the amount of gain gradually diminishes as the speed increases, and as other elements enter into the calculation at very high speeds, there is a practical limit, lying somewhere between 4,000 and 7,000 feet per minute, beyond which further increase of belt-speed results in loss rather than gain.

Increase of belt-speed by increasing the revolutions of the shaft is not all gain, because the load carried by the shaft moves a greater distance on its friction surface. So also there is an attendant loss connected with increase of belt-speed by increasing the pulley-diameters, because, while larger diameters may have less face, the weight increases with the increasing diameter faster than it diminishes with the diminution of the face.

To make this matter clearer, and also to show the effect of a series of successive changes, I have assumed certain conditions where power is to be delivered from a line shaft, and have prepared certain tables to facilitate the calculations. Table I gives the diameters of shafts required for different horse powers at different speeds. Table II gives the belt-speeds, and the motive force that is required at each speed to produce one horse power. The upper figures are belt-speeds, and the lower ones are motive forces, and the product of any couple of them equals 33,000.

TABLE I.

HORSE POWER.	DIAMETER OF SHAFTS.												
	Revolutions per Minute.												
	100	125	150	175	200	225	250	275	300	325	350	375	400
1	1⅛	1	1	⅞	⅞	⅞	⅞	⅞	¾	¾	¾	¾	⅝
2	1⅜	1¼	1¼	1⅛	1⅛	1⅛	1	1	1	⅞	⅞	⅞	⅞
3	1⅝	1½	1⅜	1¼	1¼	1¼	1⅛	1⅛	1⅛	1⅛	1⅛	1⅛	1
4	1¾	1⅝	1½	1⅜	1⅜	1⅜	1¼	1¼	1¼	1¼	1⅛	1⅛	1⅛
5	1⅞	1¾	1⅝	1⅝	1½	1½	1⅜	1⅜	1⅜	1¼	1¼	1¼	1¼
6	2	1⅞	1¾	1⅝	1⅝	1½	1½	1½	1⅜	1⅜	1⅜	1⅜	1¼
7	2⅛	2	1⅞	1¾	1⅝	1⅝	1½	1½	1½	1½	1⅜	1⅜	1⅜
8	2⅛	2	1⅞	1⅞	1¾	1⅝	1⅝	1⅝	1½	1½	1½	1½	1⅜
9	2¼	2⅛	2	1⅞	1⅞	1¾	1¾	1⅝	1⅝	1½	1½	1½	1½
10	2⅜	2¼	2⅛	2	1⅞	1⅞	1¾	1¾	1⅝	1⅝	1⅝	1½	1½
12	2½	2⅜	2¼	2⅛	2	1⅞	1⅞	1⅞	1¾	1¾	1⅝	1⅝	1⅝
14	2⅝	2⅜	2¼	2⅛	2⅛	2	2	1⅞	1⅞	1¾	1¾	1⅝	1⅝
16	2¾	2½	2⅜	2¼	2¼	2⅛	2⅛	2	2	1⅞	1⅞	1¾	1¾
18	2⅞	2⅝	2½	2⅜	2¼	2¼	2⅛	2	2	1⅞	1⅞	1⅞	1⅞
20	3	2¾	2½	2½	2⅜	2¼	2¼	2⅛	2⅛	2	2	1⅞	1⅞
25	3¼	3	2¾	2⅝	2½	2½	2⅜	2¼	2¼	2⅛	2⅛	2	2
30	3⅜	3⅛	3	2¾	2⅝	2⅝	2½	2½	2⅜	2⅜	2¼	2¼	2⅛
35	3½	3¼	3⅛	3	2⅞	2¾	2⅝	2½	2½	2⅜	2⅜	2⅜	2⅛
40	3⅝	3⅜	3¼	3⅛	3	2⅞	2¾	2⅝	2⅝	2½	2½	2⅜	2⅜

TABLE II.

Diameter of Pulley.	Belt Speed and Motive Force per Horse Power.												
	Revolutions per Minute.												
	100	125	150	175	200	225	250	275	300	325	350	375	400
8	209	262	314	366	419	472	523	575	628	680	733	785	838
	158	126	105	90	79	70	63	57.4	52.5	48.5	45	42	39.4
10	262	327	393	458	523	589	654	720	785	851	916	982	1047
	126	101	84	72	63	56	50.4	45.8	42	38.8	36	33.6	31.5
12	314	392	471	550	628	707	785	864	942	1021	1100	1179	1257
	105	84	70	60	52.5	46.6	42	38.2	35	32.4	30	28	26.3
14	366	458	550	641	733	824	916	1007	1100	1192	1283	1375	1466
	90	72	60	51.4	45	40	36	32.9	30	27.7	25.7	24	22.5
16	419	523	628	733	838	942	1047	1152	1257	1362	1466	1571	1676
	79	63	52.5	45	39.4	35	31.5	28.6	26.3	24.2	22.5	21	19 7
18	471	588	707	825	942	1060	1178	1296	1414	1532	1649	1767	1885
	70	56	46.7	40	35	31.1	28	25.5	23.3	21.5	20	18.7	17.5
20	523	654	785	916	1047	1178	1309	1440	1571	1702	1833	1963	2094
	63	50.4	42	36	31.5	28	25.2	22.9	21	19.4	18	16.8	15.75
22	576	720	864	1008	1152	1296	1440	1584	1728	1872	2016	2160	2304
	57.4	45.8	38.2	32.9	28.6	25.5	22.9	20.8	19	17.7	16.4	15.3	14.3
24	628	785	942	1100	1257	1414	1571	1728	1885	2042	2199	2356	2513
	52.5	42	35	30	26.3	23.3	21	19	17.5	16.2	15	14	13
26	680	850	1021	1191	1361	1531	1701	1871	2041	2211	2382	2552	2723
	48.5	38.8	32.4	27.7	24.2	21.5	19.4	17.7	16.2	14.8	13.8	12.9	11.7
28	733	916	1100	1283	1466	1649	1833	2016	2199	2382	2566	2749	2932
	45	36	30	25.7	22.5	20	18	16.4	15	13.8	12.8	12	11.25
30	785	981	1178	1375	1571	1767	1963	2159	2356	2552	2749	2945	3142
	42	33.6	28	24	21	18.7	16.8	15.3	14	12.9	12	11.2	10.5
32	838	1047	1257	1466	1676	1885	2095	2305	2514	2724	2933	3142	3351
	39.4	31.5	26.3	22.5	19.7	17.5	15.75	14.3	13	11.7	11.25	10.5	9.83
34	890	1112	1335	1557	1780	2002	2225	2447	2670	2892	3115	3337	3561
	37.1	29.8	24.5	21.2	18.6	16.5	14.9	13.5	12.4	11.4	10.6	9.9	9.3
36	942	1178	1414	1649	1885	2120	2356	2591	2827	3062	3298	3534	3770
	35	28	23.3	20	17.5	15.5	14	12.7	11.7	10.75	10	9.37	8.75
38	995	1244	1492	1741	1990	2239	2487	2736	2985	3134	3482	3731	3980
	33.2	26.4	21.7	18.8	16.6	14.6	13.2	12.1	10.8	10.55	9.5	8.9	8.3
40	1047	1309	1571	1833	2094	2356	2618	2880	3142	3403	3665	3927	4189
	31.5	25.2	21	18	15.7	14	12.6	11.5	10.5	9.7	9	8.4	7.9
42	1100	1375	1650	1924	2199	2474	2749	3024	3299	3574	3848	4123	4398
	30	24	20	17.1	15	13.3	12	10.9	10	9.3	8.57	8	7.5
44	1152	1440	1728	2016	2304	2592	2880	3168	3456	3744	4032	4320	4608
	28.6	22.9	19	16.4	14.3	12.7	11.5	10.42	9.5	8.8	8.2	7.7	7.15
46	1204	1505	1806	2112	2408	2709	3010	3311	3612	3913	4215	4516	4817
	27.4	22	18.3	15.6	13.7	12.2	11	10	9.1	8.4	7.8	7.3	6.85
48	1257	1571	1885	2199	2513	2827	3142	3456	3770	4084	4398	4712	5026
	26.3	21	17.5	15	13	11.7	10.5	9.5	8.75	8.10	7.5	7	6.57
54	1414	1767	2120	2474	2827	3180	3534	3887	4241	4594	4948	5291	5655
	23.3	18.7	15.5	13.3	11.7	10.4	9.33	8.5	7.8	7.2	6.67	6.25	5.85

Width of Belt = 1 inch for each 50 pounds motive force.

Table III on page 639 gives the surface speed of shafts,—that is, the number of feet per minute through which the load on the journals has to move. Table IV gives the approximate weight of pulleys. These tables can be used for other calculations of a similar character, and I may say, in passing, that such calculations have an advantage entirely apart from the economy that may be effected in any particular case, in that they give a clear idea of what is advantageous and what is not. The person who has once mastered the intricacies of such calculations as follow (and they are not difficult) can readily make changes which he will know, without calculation, to be economical, though he may not know the extent of the saving.

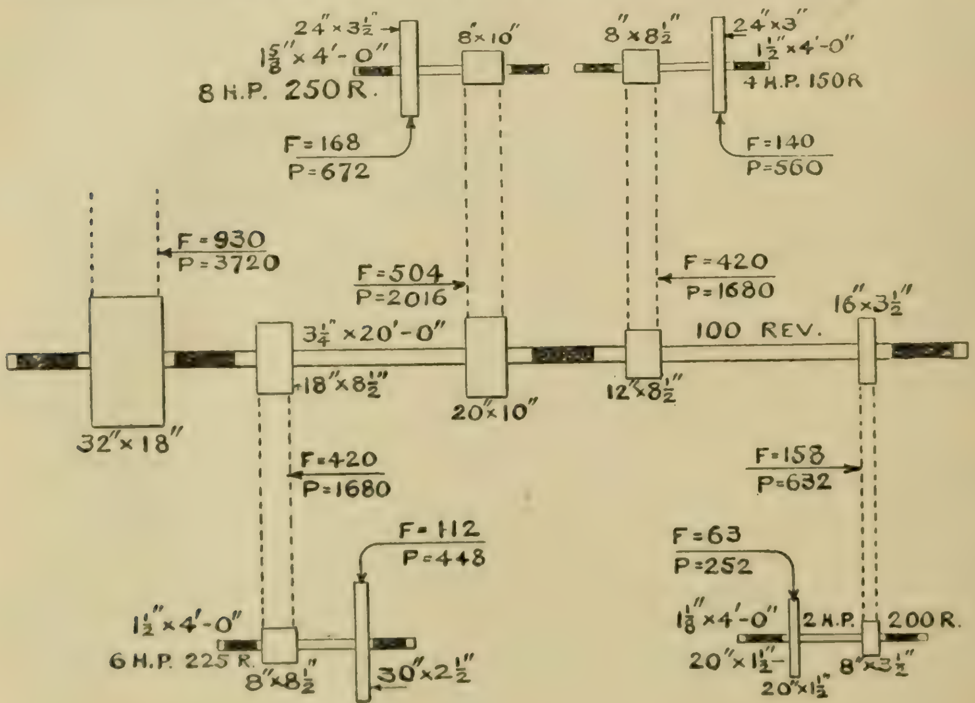


FIG. I.

The conditions assumed are that four machines, requiring 2, 4, 6, and 8 h.p. respectively, are located on a floor by themselves. Required, a main line of shafting 20 feet long, and belting to counters for these machines. What arrangement and sizes are best, and what horse power must be delivered to the main line?

It is probable that the arrangement shown in Fig. 1 would, in a majority of cases, be considered satisfactory. Certain figures are added for facilitating the calculations, in which F = the motive force required to transmit the given h. p. at the speeds used, and P = the pressure on the journals due to the pull of the belts, which is taken as 4 F. In the calculations which follow no account is taken of any losses except those which occur at the journals, the assumption being

TABLE III.

Diameter of Shaft.	Surface Speed of Shafts.												
	Revolutions per Minute.												
	100	125	150	175	200	225	250	275	300	325	350	375	400
½ . . .	13.1	16.3	19.65	22.9	26.1	29.4	32.7	36	39.3	42.6	45.8	49.1	52.3
⅝ . . .	16.35	20.5	24.65	28.6	32.7	36.8	41	45	49.1	53.1	57.2	61.3	65.4
¾ . . .	19.65	24.6	29.4	34.35	39.3	44.15	49.1	54	58.9	63.8	68.7	73.6	78.5
⅞ . . .	22.9	28.7	34.3	40	45.8	51.5	57.3	63	68.7	74.4	80.1	85.9	91.6
1 . .	26.1	32.8	39.3	45.8	52.3	58.9	65.4	72	78.5	85.1	91.6	98.2	104.7
1⅛ . . .	29.5	36.9	44.1	51.6	58.9	66.2	73.6	81	88.3	95.7	103.1	110.5	117.8
1¼ . . .	32.7	41	49.1	57.2	65.4	73.6	81.8	90	98.1	106.3	114.5	122.7	130.9
1⅜ . . .	36	45	54	63	72	81	90	99	108	117	126	135	144
1½ . . .	39.3	49.1	58.9	68.7	78.5	88.3	98.2	108	117.8	127.6	137.5	147.2	157.1
1⅝ . . .	42.5	53.2	63.8	74.4	85	95.7	106.3	116.9	127.6	138.2	148.8	159.4	170.1
1¾ . . .	45.8	57.3	68.2	80.1	91.6	103	114.5	126	137.4	148.8	160.3	171.7	183.2
1⅞ . . .	49.1	61.3	73.6	85.9	98.1	110.4	122.7	135	147.2	159.5	171.8	184	196.3
2 . . .	52.3	65.4	78.5	91.6	104.7	117.8	130.9	144	157.1	170.2	183.3	196.3	209.4
2⅛ . . .	55.6	69.5	83.4	97.3	111.2	125.1	139.1	153	166.9	180.8	194.7	208.5	222.5
2¼ . . .	58.9	73.6	88.3	103.1	117.8	132.4	147.3	162	176.7	191.4	206.2	220.7	235.6
2⅜ . . .	62.1	77.7	93.2	108.8	124.3	139.8	155.4	171	186.5	202	217.6	233	248.7
2½ . . .	65.4	81.8	98.1	114.5	130.9	147.2	163.6	179.9	196.3	212.7	229	245.3	261.8
2⅝ . . .	68.7	85.9	103	120.2	137.4	154.6	171.8	189	206.1	223.3	240.5	257.6	274.9
2¾ . . .	72	90	108	126	144	162	180	198	216	234	252	270	288
2⅞ . . .	75.2	94.1	112.9	131.7	150.5	169.4	188.2	207	225.8	244.6	263.5	282.3	301.1
3 . . .	78.5	98.2	117.8	137.5	157.1	176.7	196.3	215.9	235.6	255.2	274.9	294.5	314.2
3¼ . . .	85	106.3	127.6	148.8	170.1	191.3	212.6	233.9	255.1	276.4	297.7	318.9	340.3

TABLE IV.

Diameter.	Approximate Weight of Pulleys.												
	Face in Inches.												
	2	3	4	5	6	7	8	9	10	11	12	14	16
8.	11	13	15	17	19	21	23	25	27	29	31	35	40
10.	13	15	17	20	23	25	28	31	33	36	38	44	49
12.	15	17	20	24	27	30	33	37	40	43	46	52	59
14.	17	19	22	27	30	35	38	42	46	50	54	61	68
16.	18	21	25	30	34	39	43	48	52	57	61	70	78
18.	21	24	29	34	39	44	48	53	58	63	66	75	84
20.	23	28	33	38	43	48	53	58	63	68	73	83	92
22.	27	32	37	42	48	53	58	63	68	73	78	88	98
24.	30	35	40	46	51	56	62	68	72	78	83	94	105
26.	33	38	44	50	56	62	67	72	78	83	89	100	111
28.	36	42	48	54	60	66	72	78	84	90	95	106	118
30.	39	45	52	58	64	70	77	83	89	95	101	113	125
32.	41	48	55	62	68	75	82	88	94	100	107	120	133
34.	45	52	59	66	73	80	87	93	100	106	112	126	139
36.	48	55	63	71	78	85	92	98	105	111	118	132	145
38.	51	58	66	74	82	90	97	103	110	117	124	138	152
40.	54	62	70	78	86	94	102	109	116	123	130	145	159
42.	58	66	74	82	90	98	106	114	121	128	136	151	166
44.	61	69	77	85	93	102	111	119	127	135	142	158	172
46.	63	72	81	90	99	108	116	124	132	140	148	164	179
48.	67	76	85	94	103	112	121	129	137	145	154	170	186
54.	76	86	96	106	116	126	136	146	156	166	176	196	206

that other things remain the same. As a matter of fact, some of the changes made—for example, the use of larger pulleys—bring about incidental economies, which will be readily understood from what has been previously said.

As shown in Fig. 1, the calculation for the 2-h. p. counter is as follows:

Weight of 1⅛″ shaft	14
Weight of 20″ × 1½″ pulley	20
Weight of 8″ × 3½″ pulley	14
P. on 20″ pulley	252
P. on 8″ pulley	632
Load on journals	932

Multiplying this by 58.9, the speed at which a 1⅛″ shaft moves at 200 revolutions per minute, we have

$$932 \times 58.9 = 54{,}895\, k,$$

in which $k =$ coefficient of friction of shafting—usually about .075.

Treating the other counters and the main line in the same way, we find the figures for k shown in column A of the annexed table. Adding these up, and reducing to horse power as follows, we have:

$$\frac{1{,}584{,}615 \times .075}{33{,}000} = 3.602$$

as the amount of h. p. lost by friction in transmitting 20 h. p. through the main line and counters to the machines, or a total of 23.6 h. p. that must be delivered to the main driving pulley.

By inspection of Fig. 1, it will be seen that, by turning the 2-h. p. and the 4-h. p. counters end for end, without changing the location of the machines, the 12″ and 16″ pulleys on the main line may be brought close together. As the pull, P, on each of these is in opposite directions, they would then neutralize each other, and the pressure on the journals of the main line would be the difference between 1,680 and 632, instead of their sum. By making this change and doing the same for the other counters, we have the arrangement shown in Fig. 2, the calculations for which are given in column B. It will be seen that this very simple change saves nearly 25 per cent. of the friction loss, as originally planned.

If the speed of the main line be raised to 200 revolutions per minute, and the pulleys be reduced in diameter so as to maintain the same belt-speed, the diameter of the shaft could be reduced to 2½ inches and the pulleys would be lighter. This would reduce the total load on the journals of the main line from 5,821 to 5,457 pounds, but would increase the friction speed from 85 to 130.9 feet per minute, and the calculation would be

$$5{,}821 \times 85 = 511{,}785\ k \text{ and}$$
$$5{,}457 \times 130.9 = 714{,}300\ k,$$

or a distinct and large loss. It is, therefore, unprofitable to make changes of that kind.

If the main line makes 200 revolutions, with the pulley-diameters maintained, the belt-speeds will be increased, and the pulley-faces may be less. Another result will be larger and narrower pulleys on the counters. The effect of this change is to reduce the load on each shaft, and to increase the friction-speed only on the main line. The result is shown in column C, in the table below, in which it will be seen that there is a saving at every point, the whole being 31 per cent. better than B and 48 per cent. better than A.

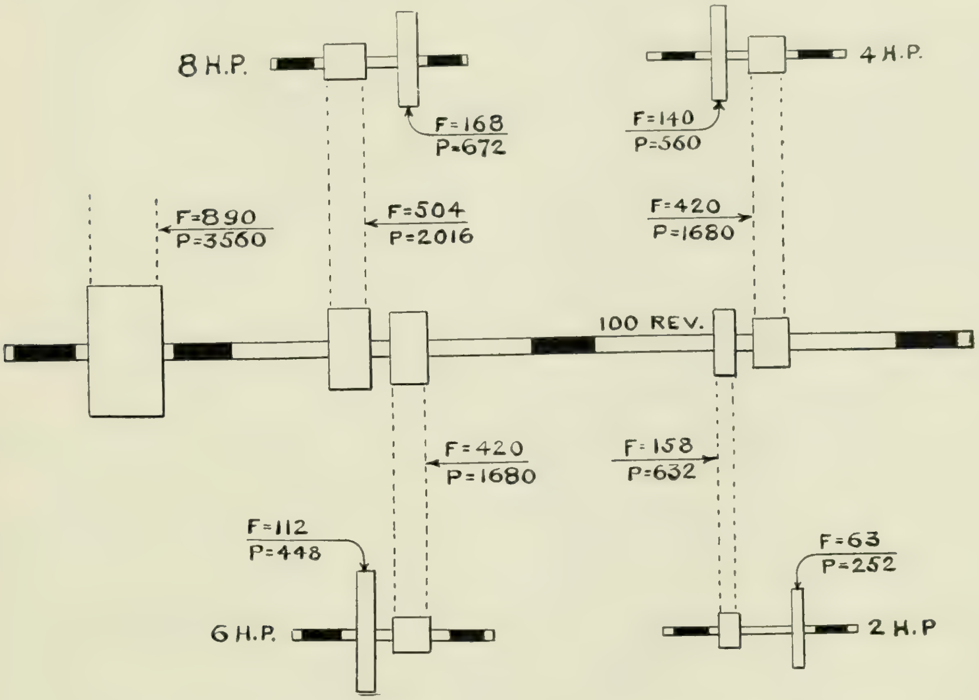


FIG 2.

TABLE SHOWING EFFECT OF CHANGES:

SHAFT.	A	B	C	D	E	F
2 H. P.	54895	54895	36518	36518	28155	23256
4 H. P.	136825	136825	87526	87526	63612	56662
6 H. P.	195850	195850	121942	121942	86090	70518
8 H. P.	295620	295620	188787	188787	136700	113584
Main	901425	508385	384581	285770	243605	199100
Total	1584615	1191575	819354	720543	558162	463120
H. P	3.602	2.708	1.862	1.638	1.268	1.052
Saving by change	....	24.8%	31.24%	12.08%	22.59%	17.03%
Total saving from A.	....	24.8%	48.31%	54.52%	63.33%	70.8%

If, instead of increasing the revolutions, the main line remain at 100 and the diameters of the pulleys be increased to obtain the same belt-speed as in the last instance, the only difference will be in the main line, where the load will be increased and the friction-speed decreased. The calculations for this condition are shown in column D, from which it will be seen that obtaining the high speed of belts by enlarging the pulleys is 12 per cent. better than obtaining it from increased revolutions.

If we use the pulley-diameters of case D and the revolutions of case C, we again increase the belt-speeds, and make a saving in each item, as shown in column E. That these successive changes may not be lost sight of the arrangement is shown in Fig. 3. By comparing Figs. 2 and 3, and the calculations for them as shown in columns B and E, we see that, by doubling the revolutions and doubling the pulley-diameters, thereby obtaining four times the belt-speed, we have saved more than half of the power previously wasted by friction.

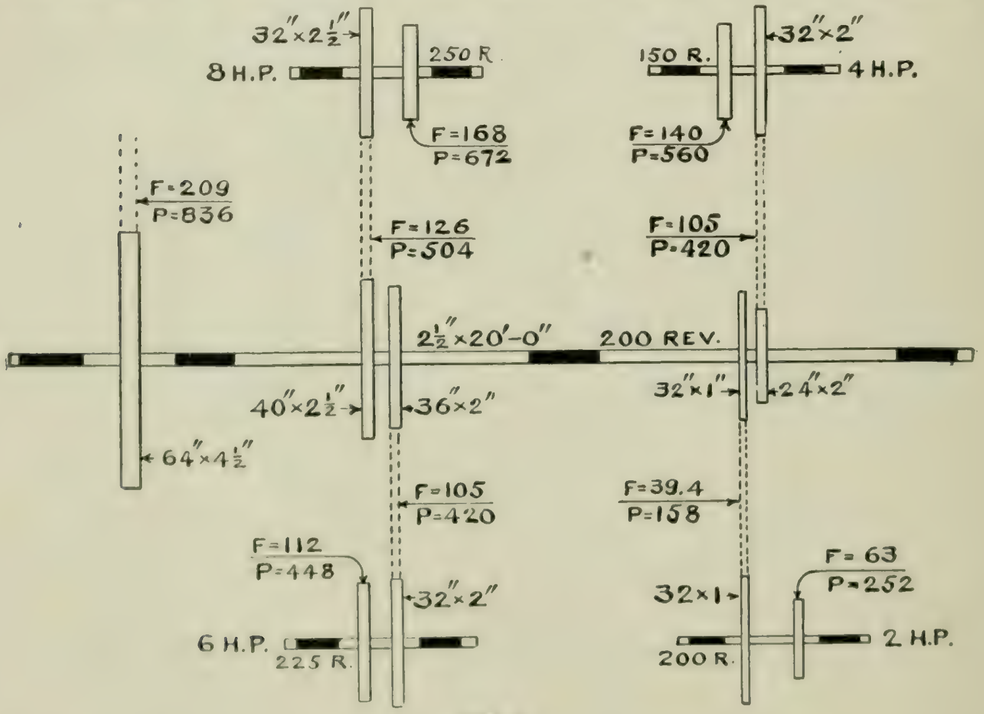


FIG. 3.

Again resorting to inspection, we see in Fig. 3 that for the 2-h. p. counter P = 158, and for the 4-h. p. P = 420. This leaves an unbalanced load of 262 pounds on the main line. If we reduce the pulleys for 2-h. p. from 32 inches to 12, we increase P for this to 420. This balances the pull on the main line by transferring the 262 pounds to the 2-h. p. countershaft. As the main shaft is 2½ inches in diameter and the countershaft only 1⅛ inches, this load does not move so rapidly; consequently there is a saving of $(130.9 - 58.9) \times 262 = 18{,}864$ k. There is also a slight saving by decrease in weight of pulleys. This illustrates the fact that it is sometimes economical to decrease belt-speeds, instead of increasing them.

If, after having obtained the balance on the main line, we again increase belt-speeds by replacing the 24-inch and 12-inch pulleys by 36-inch and 18-inch pulleys respectively, putting suitable pulleys on the counters, we do not disturb the balance, while we reduce the pull on each counter from 420 to 280 pounds, less the increased weight of pulleys. This gives an additional saving of nearly 18,000 k. Under the conditions last assumed, the 2-h. p. countershaft is $1\frac{1}{8}$ inches in diameter, runs 200 revolutions per minute, and carries 18-inch and 20-inch pulleys. If these pulleys be increased to 36 and 40 inches, and the shaft to $1\frac{3}{8}$ inches, the belt-speeds to the main line and to the machine will be maintained, and the load on the journals only slightly increased, while the friction-speed will be reduced from 58.9 to 36 feet per minute as a consequence of reducing the revolutions from 200 to 100. Following the same process for the 6-h. p. and 8-h. p. countershafts, reducing their speeds respectively to 150 and 200 revolutions per minute, and aggregating the whole, we have the results shown in column F, from which it is seen that we have obtained a saving of 70.8 per cent. of the power required by the arrangement shown in Fig. 1.

The series of changes that have been explained in detail show that the original arrangement was extravagantly wasteful; yet it is a fair representation of what may be seen in many places. In the first instance, the loss of power was about 16 per cent. of that delivered to the main line, which loss is reduced by the changes to about 5 per cent. in the last case. Ordinarily 20 h. p. would be carried through much longer lines and be divided into much smaller units. In such cases the percentage of loss would be greater, and the saving by improved arrangement correspondingly large. Instances are on record of losses ranging from 30 to 40 per cent., and even more, of the total. In such cases part of the loss is probably due to bearings being out of line or shafts bending under the loads they carry, and to incidental causes purposely omitted from the calculations presented.

THE CYANID PROCESS FOR GOLD ORES IN WESTERN AMERICA.

By Thomas Tonge.

THE annually-expanding output of gold in America is attracting more and more attention, and resulting in the investment of an ever-increasing amount of capital in gold-mining and gold-ore-treatment enterprises. Much of the recent gold production is owing to the improved methods of extracting the gold from the low-grade and refractory ores which in former years were left either in the mine, or on the dump, or in the stamp-mill tailings, because there was then no known method for the economical and profitable recovery or saving of the gold values in such ores.

The revolution since effected is largely owing to the discovery and subsequent development of the cyanid process. While it had been known for many years that potassium cyanid was a solvent of gold, it had been used only in a very limited way,—in the laboratory or in the treatment of the plates of amalgamation batteries,—and it was not then known by practical men that a weak solution of cyanid would dissolve crude and complex ores direct.

In 1867 a United States patent was issued to Julio Rae for the treatment of argentiferous ores by potassium cyanid and electricity in combination. In July, 1885, a United States patent was issued to Jerome W. Simpson for the treatment of ores by a combination of potassium cyanid and ammonium carbonate. But neither of the foregoing processes was capable of successful operation commercially, owing to the fact that there was then no known method of recovering the precious-metal values from the solutions.

In October, 1887, letters patent were issued in Great Britain to John S. McArthur, Robert W. Forrest, and William Forrest, covering what is now commonly known as the McArthur-Forrest cyanid process, which treats crushed ore, either by agitation or percolation, —preferably percolation,—with a very diluted solution of potassium cyanid, the gold being precipitated upon zinc shavings, or by the Siemens-Halske process, or precipitation by electricity, on sheet lead, the slimes of zinc and gold, or the amalgam of lead and gold, being subsequently refined in the ordinary way and the pure gold extracted.

The United States patent for the McArthur-Forrest process was obtained in May, 1889, and in May, 1890, the first company in the United States—*viz.*, The Gold and Silver Extraction Mining and Mill-

WORKS OF THE METALLIC EXTRACTION CO., CYANIDE, COLORADO.

ing Co.—was organized in Denver, Colorado, to operate the process in America. The company at once established in a suburb of Denver a demonstration plant sufficiently large to handle carload lots. Among the first large samples was one from what is now known as Mercur, Utah, in a district which has since become famous as a gold producer, entirely owing to the adoption of the cyanid process and its improvements from time to time.

As showing the incredulity with which the process was at first received, it may be mentioned that the first carload of Mercur ore was taken seven hundred miles to the demonstration plant at Denver, by

THE BRODIE REDUCTION MILL, CRIPPLE CREEK, COLORADO.

SPANISH GOLD MILL, BINGHAM CAÑON, UTAH.

Mr. Gill S. Peyton, who was the assayer and one of the owners of the Mercur Mine (for which property a considerable sum had been paid, only to find that no then known process would profitably take out the gold values). Mr. Peyton's partners were so incredulous as to the new process that they not only discountenanced the shipment, but declined to defray any of the expense. He, however, took out the ore and loaded it on a car; but, not having sufficient money to pay the freight, he went on to Denver, where he induced the manager of the Cyanid Company to advance the necessary sum, on condition that Mr. Peyton would put on his overalls, go into the mill, and personally witness and check off the work of the company's chemist in charge of the operations, so that he would be thoroughly satisfied as to the efficiency of the process. The car of ore duly arrived, and the merits of the process were clearly demonstrated, with Mr. Peyton as an eye-witness. He returned to Utah, raised the necessary money, and put up a small plant with a capacity of ten tons per day. Since that time the Mercur district has produced millions of dollars in gold, and the present aggregate daily capacity of the local cyanid plants is nearly five hundred tons.

About the time that Mr. Peyton was investigating, Mr. Almarin B. Paul, of San Francisco, one of the leading metallurgists in California, visited Denver to investigate the new process, and, if found satisfactory, to arrange for its introduction into California. As a result he organized the Shasta Gold Extraction Company, and erected a plant at Metal Creek, Shasta county, California, which was operated successfully, with a high percentage of extraction, so long as the local ores lasted. He also arranged with another company in the same county for a plant, which has been in successful operation for several years.

About that time also a license to use the process was granted to the Livingstone Gold Mining Company in the Sugar Loaf district, Boulder county, Colorado, which mill was operated successfully for severa years—as long as the ore was taken from the mine.

In the fall of 1892 Mr. R. B. Turner visited Denver with a carload of ore from the Revenue mine, Madison county, Montana. So high a percentage of the values in this carload of ore was saved at the Denver experimental plant that Mr. Turner returned to Montana and erected a plant ; it was only partially successful, as stamps and wet crushing were used, causing the ores to slime so badly as to prevent good filtration. A second mill was then erected, where rolls and dry crushing avoided the making of slimes ; this proved successful.

During the above period there were other plants started. In November, 1893, the Gold and Silver Extraction Mining and Milling Co. sold out the Colorado incorporation to The Gold and Silver Extraction Company of America, Limited. The latter company, organized under the laws of Great Britain and with American headquarters in Denver, now has the ownership or control in America of the original McArthur-Forrest cyanid process.

In September, 1894, The American Cyanid Gold and Silver Re-

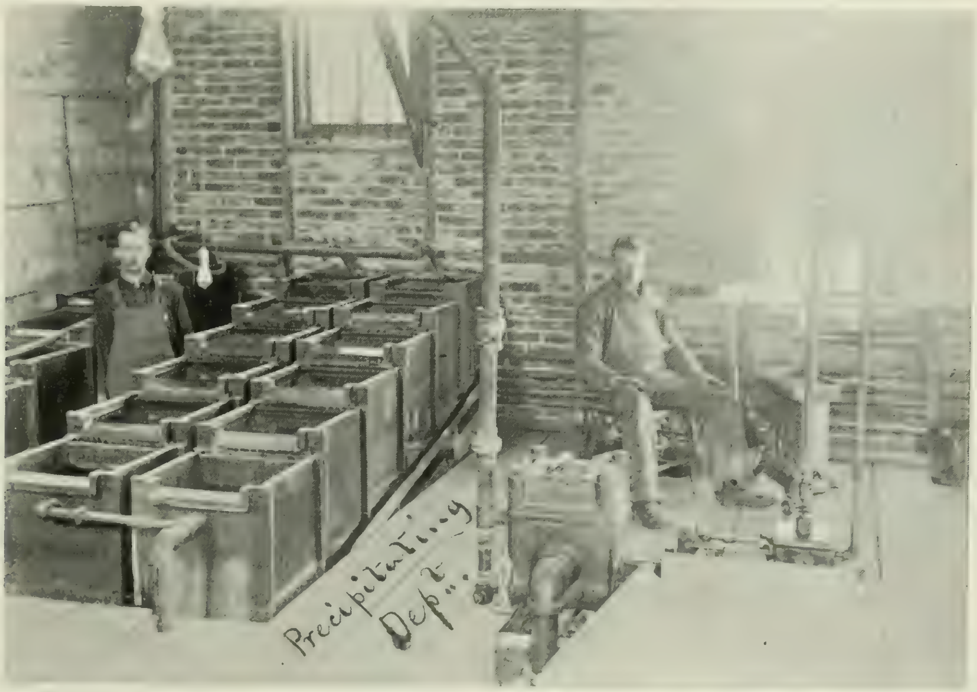
INTERIOR OF 60-TON TANK, METALLIC EXTRACTION CO., CYANIDE, COLORADO.
Moffat-Smith McArthur-Forrest Process.

PRIMITIVE CYANID PLANT ON CLEAR CREEK, NEAR DENVER, COLORADO.

CYANID PLANT OF NIAGARA CO., BINGHAM CAÑON, UTAH.

covery Company came into existence, also with headquarters in Denver, Colorado. This company is based on the Kendal process, covering a combination of sodium dioxid and potassium cyanid. The company holds several United States patents covering processes for the recovery of the precious metals from solutions.

In the meantime a third company came into existence, under United States patents issued in 1894, 1895, and 1896, also with American headquarters in Denver,—*viz.*, The General Gold Extracting Company, Limited, based on the Pelatan-Clerici process, which is a treatment of the crushed ore by agitation in a diluted solution of potassium cyanid, with an electrical current and direct precipitation upon mercury.



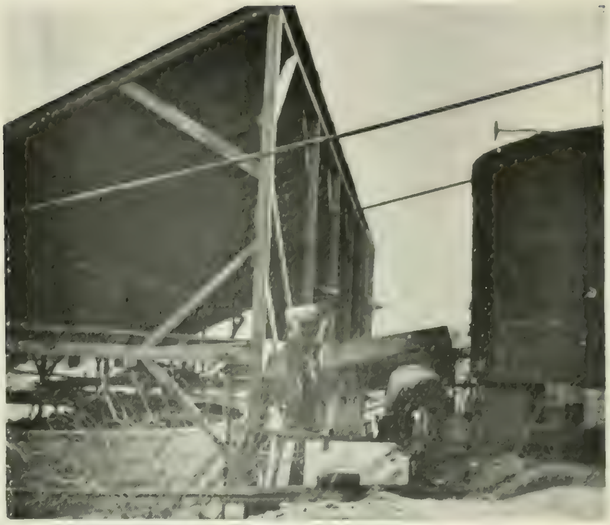
PRECIPITATING BOXES, WISWALL-FRANK PROCESS.

It is no part of this article to deal with the rival claims or alleged advantages of these three competing enterprises, but rather to deal with the cyanid process generally, apart from the controversial phases, and its importance as a factor in the increasing production of gold from ores which could not previously be mined and treated at a profit. Those mine-owners and capitalists who are disposed to utilize the process can decide for themselves, after full investigation, which process they will adopt.

The following incomplete list of the cyanid plants in operation in the gold-producing States and territories shows the wide extent to which the process, in one or other form, has been adopted :

Plant.	Material Treated.	Tons per Day.
Arizona.		
Congress Mill (Yavapai county)	tailings	100
Haquahala Mill (Yuma county,)	“	100
Fortuna Mill (Yavapai county)	“	75
Helm Mill, Wickenburg (Maricopa county)	“	50
McLeish Mill (Maricopa county)	“	50
Tombstone (Cochise county)	“	10
California.		
Bodie Mill, Bodie (Mono county)	“	150
Standard Mill “ “ “	“	150
Young America Mill, Sierra Nevada Mts.	“	50
Parr & Tyack Mill, Bodie	“	25
Hunt & Holbrook Mill (Amador county)	“	25
Black Oak Mine Mill	“	15
Maydwell Hart Mill (San Bernardino county)	“	10
Dunderberg Gold Mines, Ltd	“	10
Stent Cyanid Co.	“	10
Colorado.		
Metallic Extraction Co., Cyanid	crude ore	400
Brodie Mill, Cripple Creek	“ “	100
American Reduction Mill, Florence	“ “	75
St. Elmo Mill (Chaffee county)	tailings	75
Arequa Gulch Mill, Cripple Creek	crude ore	50
Holy Cross Mill (Eagle county)	“ “	50
Leadville G. & S. Extr. Co. (Lake county)	“ “	50
Idaho.		
Delamar Mill (Owyhee county)	crude ore	50
Idaho Recovery Co. Mill	“ “	50
Montana.		
Revenue Mill, Revenue	crude ore	60
Harsh Mill (Lewis county)	“ “	50
Mueller Mill (Madison county)	“ “	25
Nevada.		
Delamar Mill, Delamar	crude ore	300
Eureka Mill, Eureka	tailings	100
Willis Mill, Battle Mountain	“	60
Pierson, Carson River	“	50
North Mountain Mill, White Pine	crude ore	50
Union Mill, Tuscarora	concentrates	50

ERECTING A SMALL CYANID PLANT.



LEACHING TANK, ZINC BOX, AND SUMP TANK.

A PRIMITIVE ARIZONA PLANT.

ANOTHER SMALL CYANID PLANT IN ARIZONA.

FORTUNA TAILING PLANT, ARIZONA.

NORTH MOUNTAIN MILL, CHERRY CREEK, NEVADA.

New Mexico.		
Homestake Mill, White Oaks	tailings	40
South Dakota.		
Black Hills Extraction Co., Black Hills	crude ore	50
Golden Reward Mill, Black Hills	“ “	40
Utah.		
Mercur Mill, Mercur	crude ore	400
Northern Light Mill (Tooele county)	“ “	200
Marion-Geyser Mill, Mercur	“ “	75
Sacramento Mill	“ “	50
Bingham Mill, Bingham	“ “	35

SUMMARY.

State or Territory.	Mills.	Tons per Day.
Arizona	6	385
California	9	445
Colorado	7	800
Idaho	2	100
Montana	3	135
Nevada	6	610
New Mexico	1	40
South Dakota	2	90
Utah	5	760
Total	41	3,365

ROASTING CYANID PLANT, CONGRESS GOLD CO., CONGRESS, ARIZONA.

PRIMITIVE CYANID PLANT ON CLEAR CREEK, NEAR DENVER, COLORADO.

The following brief description by the superintendent of the cyanid plant at Congress, Arizona, treating tailings, gives a fair idea of the others:

> The plant is running on tailings from our forty-stamp concentrating mill. There is a very large accumulation of tailings, and more are being made all the time at about the rate that they are used. The tailings are dried, put through a Stedman pulverizer, and elevated to the storage-bin shown on the left of the photograph. From this bin they are fed automatically to a Brown roasting furnace, where they are thoroughly desulphurized and oxidized. Emerging from the roaster, they pass over a cooling floor, and discharge into a bin which feeds the elevator used in charging the tanks. Hand labor is thus almost entirely dispensed with from the time the tailings enter the pulverizer until the leaching process is completed and the tailings, exhausted of their gold contents, are ready to go on the dump as final waste. The discharging is done by hand, as the water-supply is not sufficient to permit of sluicing.
>
> The leaching tanks are 26 feet in diameter by 4½ feet deep. Zinc precipitation is used, and the bullion produced is between 800 and 900 fine. The zinc house is on the extreme left. Crude oil is used for fuel in the roasting-furnace, and coal under the boiler. A spur from our railroad runs into the works for bringing in supplies.

In addition to the mills mentioned in the foregoing list, there are various smaller plants. An illustration is given of one of these somewhat primitive enterprises on Clear Creek, a few miles from Denver, treating material taken from the banks or bed of the stream, which drains the auriferous districts of Gilpin and Clear Creek counties, lying about forty miles up stream from the plant in question.

It is now seven years since the cyanid process was introduced into America, South Africa, and New Zealand. In each country a rapid increase in the output of gold bullion has taken place as a consequence. A wonderful stimulus has been given to gold mining, while abandoned mines and tailing dumps have been the scenes of renewed activity, and have been made to pay handsomely.

Gold ores may be broadly divided into two classes:

(1) Those that yield up their gold entirely, or nearly so, to treatment with mercury and various other methods; (2) those of too low grade for smelting, and from which the gold cannot be extracted in any other way, or only in so partial a manner as to give no profitable results.

The former are known as "free gold" or "free milling" ores, and the latter are variously termed "refractory" or "rebellious" ores, for the reason that they cannot be worked profitably by ordinary amalgamation.

In the "refractory" ores ingredients are invariably found which act upon the mercury, or the chemicals with which extraction has hitherto been attempted, to the extent of preventing effect upon the gold and silver which it is sought to recover. Many of these ores are especially amenable to the cyanid process.

For every ton of "free gold" ore, or "free milling" ore, there are hundreds of tons of ore, too low in grade to pay for the necessary hauling, railroad freight, and smelting, and so refractory that

IDAHO RECOVERY COMPANY'S PLANT.

they have hitherto been either left in the mine or thrown as valueless on the waste dump, although frequently showing richer assay values than the free milling ores actually treated.

PRIMITIVE HOISTING WHIM.

In the vast region lying between the British line and the borders of Mexico, and from Denver westward to the Pacific, there are millions of acres of mineral lands, containing thousands of strong veins of refractory ores, which await only a proper process of gold extraction to render them highly profitable. In many such cases the cyanid process presents the solution of this great commercial problem, and every year sees this solution nearer. Moreover, the cyanid process is particularly applicable to ores containing gold in those minute particles which, in the stamp and amalgamating process, are largely lost in the slimes.

There are about forty cyanid plants operating on the different mines in the Witwatersrand district of South Africa, where, however, the question is infinitely simplified by the fact that they deal with a uniform ore, this ore being treated by amalgamation, to save as much gold as possible on the plates, and the tailings being then subjected to the cyanid process. Yet only about seventy per cent. of the gold value in the tailings is recovered.

In America, on the contrary, the question was and is much more difficult and complicated, as an infinite variety of crude, refractory ores are successfully treated and from eighty to ninety-five per cent. of the gold values saved. In America the cyanid process treats at a profit tailings averaging as low as three dollars per ton, the total cost of handling, chemicals, etc., being about fifty cents per ton and the net profit two dollars and fifty cents per ton. At one place crude ore averaging as low as five dollars and fifty cents in gold and three ounces of silver per ton is mined, hauled, crushed, and treated by the cyanid process at a comparatively handsome profit.

The cyanid process, however, is not exempt from the undeserved failures arising from ignorance, incompetence, and careless inattention to necessary details and even to fundamental principles. Men who have not thoroughly mastered its theory and practice build plants which do not admit of the most economical and efficient gold extraction, and in the operation of these plants the maximum of chemicals is sometimes used and the minimum of gold extraction effected, to the great injury of the owners of both mines and plants, who frequently are oblivious to wasteful methods and consequent money losses.

The following unassailable principles must be recognized:

(1) That no cyanid plant should be erected until the ores proposed to be treated have been thoroughly tested by a cyanid expert of undoubted ability and integrity, and pronounced entirely suitable for the process, or for some modification thereof adapted to that particular class of ore.

(2) That no cyanid plant should be erected, except on the plans and under the supervision of a man who has made a special study of the process.

(3) That such a plant, when completed, should be placed under a manager who has had a thorough technical and practical training in the process.

Failures following any ignoring of these precautions cannot justly be charged to the process.

REVIEW OF THE ENGINEERING PRESS

CONTENTS.

ARCHITECTURE AND BUILDING.

Architectural Distortion 666
Cantilever Foundations 670
The Proper Study of Architecture...... 675

CIVIL ENGINEERING.

The American Society of Civil Engineers 665
Deep Waterways to the Atlantic.........667
Hydraulic Dredging...... 669
The Measurement of Wind Pressure.... 679
The New Faidherbe Bridge 684
Photographic Altitude Measurements 686

ECONOMICS AND INDUSTRY.

The Engineers' Strike 673
Diagram Accounts.....................676
The Cost of Power....................687

ELECTRICAL ENGINEERING.

Electro-Chemical Progress.............675
Electrical Transmission in Workshops ...682

MARINE ENGINEERING.

United States Gunboat Trials...........670

MECHANICAL ENGINEERING.

The Calorific Value of Coals...........666
Rope Driving.................... ... 668
Mathematics for Engineers.............671
The Purification of Feed Water 672
Compression in Steam Cylinders 681
A New Method of Testing Materials 682
The Strength of Cylinder Heads........683

MINING AND METALLURGY.

Metallography as a Method of Research..685
Mixtures of Iron and Steel 685

MUNICIPAL ENGINEERING.

Acetylene Mixtures......... 674
Fire Protection in London...... 680
Sewage Purification at Spandau... 686

RAILWAY AFFAIRS.

High-Speed Locomotives 677
The Caillet Monorail..................683

STREET AND ELECTRIC TRAMWAYS.

Electrical Traction 678

The American Society of Civil Engineers.

WE have already chronicled in these columns the completion of new homes for the French, German, and British engineering societies, and the American Society of Civil Engineers is not far behind, the new building for this, the oldest of the engineering societies of the United States, having been publicly opened on November 24, 1897.

This event is duly recorded in most of the engineering journals, but we must remark especially the fine view of the building in the *Iron Age* of November 25.

The American Society of Civil Engineers dates from 1852, and has numbered among its members some of the most distinguished engineers in the United States, as well as many able men of foreign countries. Originally the society occupied rooms at William and Cedar streets, New York, subsequently shifting as the membership increased, until in 1881 the quarters in Twenty-third street were purchased. The new building, situated at No. 220 West Fifty-seventh street, is a handsome structure of the French renaissance school, from designs by Mr. C. L. W. Eidlitz, and has been carefully planned to meet the requirements of the society. In addition to business offices and a conversation room on the first floor, there is on the second floor a fine auditorium, seating more than four hundred persons, and also a convenient reading-room. The books are stacked on the fourth floor, where there is a capacity for one hundred thousand volumes, and an electric book-lift serves to convey the volumes to and from the reading-room. The third floor is devoted to the model-room and museum, so that the entire building is appropriated to engineering purposes.

The cost of the structure was $200,000, including the ground, the assets of the society being about $250,000, and its income about $40,000 per annum, the membership being over twenty-five hundred.

The Calorific Value of Coals.

WITH the increasing practice of rating boilers by a comparison of the heat units in the steam with the calorific value of the coal there has come a renewed interest, not only in the heating power of coals from various sections, but also in the methods for determining that heating power.

This question forms an important portion of the preliminary draft of the report of the committee of the American Society of Mechanical Engineers, submitted at the December meeting at New York and incorporated in the *Transactions;* and is also the subject of a paper presented before the American Institute of Mining Engineers by Mr. William Kent at its Lake Superior meeting.

The report of the boiler-test committee is emphatically favorable to the use of the Mahler calorimeter, and recommends that method whenever practicable; and, as the apparatus is now available in many laboratories, samples of the coal used in a boiler test may be reserved, and the calorific value subsequently determined.

When the calorimeter is not at hand, recourse must be had to chemical analysis, generally using the formula of Dulong, and substituting the values for carbon, oxygen, and hydrogen from the analysis.

Mr. Kent's paper is a discussion of the valuable experimental tests of Messrs. Lord and Haas, presented at a previous meeting of the American Institute of Mining Engineers, and shows in a very interesting manner how fully these tests of American coals fall into the general range of coals of various composition, as classified by calorific value. In their original memoir Messrs. Lord and Haas thought that no general law could be found to govern the calorific power of coals, but Mr. Kent has plotted the curve for Mahler's tests, using as ordinates the number of calories per pound of coals and as abscissas the percentage of fixed carbon, and shows very clearly that the tests of Mahler, Lord, Haas, and Houghton agree much better than had been supposed possible.

The question as to the propriety of including a factor for the heat of the sulphur in the coal is one about which there has been some discussion, and in a note to the report of the boiler-test committee Mr. Kent objects to the use of such a factor, on the ground that the sulphur does not exist in the free state, but as sulphide of iron, etc., and has little or no value as fuel. Professor Lord has shown, however, that there is a very definite heat-value attributed to the combustion of the pyrites to sulphuric acid, and in Germany Baron Jüptner von Jonsdorff, who has also made an elaborate analysis of the tests of Messrs. Lord and Haas, distinctly includes the calorific value of the sulphide of iron as burned to SO_3.

The Society of German Engineers, and the International Society for Boiler Inspection, have united upon a modification of the Dulong formula, which is known as the *Verbands-Formel*, and which includes terms for sulphur, and for moisture, together with slightly modified values for the constant coefficients; and, unless there is some very good reason for doing otherwise, it is to be hoped that the boiler-test committee of the American Society of Mechanical Engineers will further the cause of international unity of methods by adopting this formula.

Architectural Distortion.

IT is a well-ascertained fact that in certain mediæval cathedrals there is a marked deviation from what would ordinarily be called correct workmanship. Walls and columns are not plumb; pillars and arches in the same colonnade are not similar in dimensions or proportions; and other apparent vagaries are found. Some have attributed these facts to ignorance or carelessness; others to the unequal settling of foundations, or the yielding of piers to the thrusts and stresses which have been thrown upon them; while some have distinctly affirmed these deviations from geometrical rectitude to be intentional and premeditated, and to form part of a system of pseudo-perspective intended to produce certain optical effects upon the spectator.

Professor William H. Goodyear has an interesting discussion of this subject in the *Architectural Review* (Dec., 1897), and his investigations of certain structures have been made with so much care that they offer excellent material for study.

That this artificial distortion was known, or at least suspected, more than two hundred years ago—that is, after the decline of mediæval architecture and before the development of modern methods—is shown by the quotation from Evelyn's diary in 1665 referring to the inspection of the tower of Old Saint Paul's by Wren, Evelyn, Chichley, Prat, and others, in which Evelyn says: "Finding the main building to recede outwards, it was the opinion of Mr. Chichley and Mr. Prat that it had been built *ab origine* for an effect in perspective, in regard of the height; but I was, with Dr. Wren, quite of another judgment, and so we entered it."

Old Saint Paul's is no longer with us for examination, but it is very likely that Chichley and Prat were right, and Professor Goodyear has given us measurements and photographs of existing buildings, notably of St. Mark's at Venice, showing that such a distortion does exist, and apparently is the result of intention.

The photographs used by Professor Goodyear were taken by Mr. McKecknie, of the Brooklyn Institute, who used every care to avoid photographic distortion. The camera was carefully plumbed and levelled, and, when tilting was found necessary, the swing-back was kept accurately vertical.

Photographs and measurements both show that the main piers supporting the dome of St. Mark's have a spread of nearly three feet in the rise from the floor to the springing of the arch; like St. Paul's, the main building "recedes outwards," and this, too, with no evidence either of settling or of yielding to thrust. A similar spread is visible in the transepts to about one-half the extent, and this deviation from the vertical is so evidently intentional as to reveal itself as a portion of the original design.

This spreading is exactly in the direction to counteract the optical tendency to convergence, and so carefully has it been done that, to the eye of an observer on the floor of the cathedral, the piers appear vertical. Observed from the gallery, where the perspective effect is lacking to correct for the spread, the distortion is apparent, but even from there it has been but little noticed. Similar effects are found in the Cathedral of Triani, in the Church of SS. Giovanni e Paolo, Bologna, and in the Church of S. Maria al Arezzo; and in all these cases a careful inspection of the masonry showed no cracking or settlement distortion. In the case of the façade of S. Ambrogio at Milan the spread is clearly shown to extend to the upper central arch in a manner which could hardly have been accidental under any circumstances, and in numerous other cases a similar state of affairs is shown to exist.

Professor Goodyear disclaims for the present any positive deductions from the facts he has so carefully observed, preferring "to consult the opinion of optical and artistic experts after the facts have been brought to light," but it is evident that he himself is convinced, as indeed most of his readers will be, that the mediæval cathedral builders knew what they were about, and labored intelligently with more or less success to introduce artificial perspective effects.

Deep Waterways to the Atlantic.

For some time the advisability of considering seriously the construction of a ship canal from the Great Lakes to the Atlantic has been discussed in various quarters, and an organization called the Deep Waterways Association has done effective work in improving the lake harbors and in agitating the question of the ship canal.

In order that the subject might be considered intelligently, the secretary of war appointed Major Thos. W. Symons, Corps of Engineers, U. S. A., to make an examination of the project. Major Symons's report has been made public, and a very full abstract, together with an editorial discussion and some interesting correspondence, is given in *Engineering News* (Nov. 11). Major Symons admits that he entered upon this task with a prejudice in favor of a ship canal, and hence the fact that his report is distinctly adverse to the project can hardly be charged to personal prejudice. He has, however, been careful to investigate the subject, not only from an engineering standpoint, but also from a commercial position, and his report certainly appears to be that of a disinterested expert.

Of course, the primary object of a ship canal to the Great Lakes would be to permit sea-going steamers to proceed directly to Chicago or Duluth, and there receive their cargoes, but this would be done only if there was a distinct commercial advantage in so doing. As a matter of fact, the exigencies of lake transportation have so developed the systems of handling and shipping there that much of the cost and delay of reshipping has been avoided, and a special division of shipping has been evolved, admirably adapted for lake traffic, but quite unsuited for ocean service. Under these circumstances Major Symons is compelled to report that he is of opinion that a canal capable of bringing the cargoes of the lake traffic to the seaboard in barges of less than 16 feet draft, there to be reloaded into the ocean steamers, is to be recommended rather than a ship canal for vessels of, say, 28 feet draft.

The cost of a 28 foot ship canal is estimated at $200,000,000, with an annual cost for maintenance of $2,000,000; assuming an interest charge of 3 per cent., the total annual cost would be $8,000,000, which, according to the report, would have to be carried by a traffic estimated roughly from present conditions at 24,000,000 tons per year, corresponding to a saving of 33⅓ cents per ton over existing methods of transportation.

In Major Symons's opinion, this saving is hardly to be expected in view of railroad competition, and it is his belief that the traffic would be better handled by a 16-foot barge canal, capable of bringing the merchandise from the lakes to New York, there to be reloaded in seagoing steamers. The cost of such a canal would be only about one-fourth that of the proposed ship canal, and could probably be carried out along the line of the present Erie Canal with a minimum of cost and a maximum of advantage.

Doubtless this will hardly meet the views of those who desire to see Chicago made a seaport, but, when all the points which Major Symons has so clearly set forth are impartially taken into account, the wisdom of his views will be admitted.

Rope Driving.

In a paper presented before the American Society of Civil Engineers upon the subject of "Rope Driving," Mr. T. Spencer Miller offers some points of undoubted value. It is well known that the driving power of a rope acting around a pulley is governed by two main factors,—the arc of contact which the rope makes with the pulley, and the angle of the groove in which the rope runs. Now, as most rope-drive installations are made where the driving and driven sheaves are of unequal diameter, and several turns of one continuous rope with tension carriage used, the various parts of the rope are found not to pull equally, a few of them doing the greater part of the work; the required tension therefore is greater than that which would be necessary if the work were more equally distributed.

Mr. Miller proposes to remove this inequality by varying the angle of the grooves in the two pulleys, in proportion to the difference in the arcs of contact, so that the strains in the various parts of the rope shall be equalized; and by this simple and ingenious method he remedies what has until now been the chief cause of loss and wear in multiple-rope transmissions.

It is not difficult to show by a concrete example how, with an equalized distribution of tensions, either the strain on the rope may be greatly reduced, giving a higher factor of safety and longer life, or, by maintaining the same tension, a corresponding increase in transmitting capacity may be gained.

For general purposes, the angle of 45° for the grooves has been found by experience to be the sharpest permissible, a more acute angle causing the rope to wedge too tightly and necessitating too much force to pull it out of the grooves at each revolution. Assuming, then, 45° as the angle for the grooves in the smaller pulley, and using a well-known formula for finding the frictional grip for any other angle, the angle for the larger pulley can at once be computed to give a grip on the larger pulley corresponding to the arc of contact.

The method is open to the objection that the pulleys must be grooved especially for the location in which they are to be used, as the arc of contact varies both with the ratio of pulley-diameters and the distance between axes; but this is worth doing, if a continuous economy is thereby effected. The small pulleys can always be grooved to the standard angle of 45°, leaving only the large drivers to be finished when the data have been obtained, and usually such wheels are made to order in actual practice.

Since rope driving is very often used in transmissions involving great differences in pulley-diameters, such as from fly-wheel to jack-shaft, or from line-shaft to dynamo, this question of equalization of tension is one which has a most practical bearing upon rope transmission, and we believe that Mr. Miller has made a valuable contribution to the subject.

Hydraulic Dredging.

THE use of the modern hydraulic dredge has extended widely during the past few years, and an important descriptive and historical paper upon the subject has been presented before the Technical Society of the Pacific Coast, by Mr. W. H. Smyth, and printed in the *Journal of the Association of Engineering Societies* (Oct. 1897).

"The art of hydraulic dredging involves: (1) The mechanical severing of material from a water bottom; (2) the lifting of the severed material therefrom by atmospheric pressure; and (3) the transporting of it (mixed with water), by mechanical pressure, through pipes, to any desired place of deposit, these three processes constituting one continuous and connected operation."

The older forms of mechanical dredging were limited to the dipper, the clam-shell, and the endless chain bucket. Suction pumping was first introduced for the purpose of lifting mud or sand, centrifugal pumps being used to draw the large volumes of semi-fluid material, and the water acting as a transporting material.

The modern hydraulic dredge,—as used extensively on the Pacific coast of the United States and elsewhere, is described by Mr. Smyth as the combination of a rotary excavator and a suction pipe, in which the material, when severed by the excavator, passes interiorly to the pipe.

In other words, the use of a rotary excavator, attached to the end of the suction pipe makes the sand or mud pump capable of handling material otherwise too solid to be separated by mere suction. The hydraulic dredge thus constructed has shown itself to be a machine of great efficiency and capacity.

Experience shows that the solid matter is carried along the lower side of the discharge pipe, and that it may be drawn off through openings in the under side of the pipe, while the bulk of the water flows out at the end, thus permitting the excavated material to be received in a sufficiently solid form for use in levee building and similar work.

The capacity to deliver solid material is naturally dependent upon the velocity of flow, and in some instances as much as 70 per cent. of solid material has been delivered at the discharge. In some cases large boulders have been brought to the surface, and almost any solid material, within the capacity of the pipe, when loosened by the excavator, may be lifted, if the velocity of the current is great.

In the discussion which followed the reading of Mr. Smyth's paper, Mr. A. B. Bowers, a pioneer in this work, gave some points connected with his experience. With discharge velocities of 15 to 20 feet per second, dredges of his design, of 400 h.p., have handled 100,000 cubic yards per month, the quantity depending upon the nature of the material. The general price for such work, when the material is to be delivered at a low elevation through a short discharge pipe, is about 15 cents a cubic yard. As Mr. Bowers well said: "The hydraulic dredge is a special tool for special work, and in its own sphere is without a rival."

Cantilever Foundations.

In the construction of the modern tall building, the foundation upon which the steel cage or skeleton rests is one of the most important parts of the structure. In New York city, especially, the difficulties offered by the natural conditions of the ground are complicated by the necessity of under-pinning the adjoining buildings, the foundations of which are generally completely undermined. This adds largely to the cost of the work, and it is stated that in some cases the foundation work has amounted to 10 per cent. of the cost of the entire structure.

In order to avoid some of these difficulties, the cantilever system has been used, and in the *Engineering Record* (Nov. 27) an account is given of the application of this method by Messrs. Crehore and Miller to some stores in New York. Test boring having revealed rock foundations not far below the surface, cylindrical steel caissons were sunk to the rock, in pairs, the centres of the caissons being more than four feet from the wall line of the building. These were then filled with concrete, forming solid pillars entirely within the foundation area of the new building and having in no way undermined the adjoining structures on either side. As the width of the building was only 25 feet, two piers were sufficient for the width, and these were arranged six deep, making twelve in all. Upon each pair of piers a steel truss was placed, being in depth 10 feet, the full basement depth, and overhanging the piers at each end by the distance necessary to reach to the outer wall line,—in this case 4 feet 4⅛ inches at each end; upon the ends of these overhanging trusses the vertical posts of the steel cage rested.

The details of the construction are well shown in the article referred to, and the whole forms an admirable example of judicious engineering. The amount of overhang to the foundation trusses is so small that it is in no way prejudicial to the stability or strength of the structure which it supports, and the substitution of the cylindrical piers and the use of the steel caissons, avoided entirely the costly method of constructing a grillage over the entire area, or of sinking pneumatic caissons along the whole foundation wall line, including the care of adjacent structures during the operation.

Apart from the economy which this form of foundation effects, it is also worthy of consideration as an exceedingly reliable method, as the loads are concentrated upon points the integrity of which can be fully assured. It is evidently not adapted for doubtful or treacherous soil, and can be recommended only where the caissons can be carried down to bedrock and an absolutely solid bearing obtained; but for such cases as are found in New York city the method offers advantages which will be evident to those who give the subject attention.

United States Gunboat Trials.

An interesting comparative trial of two gunboats built for the United States government by the Union Iron Works of San Francisco is given in the *Journal of the American Society of Naval Engineers*, by P. A. Engr. F. C. Bieg, U. S. N., from which some notes are extracted.

The two vessels under consideration are the Wheeling and the Marietta, and, as the report says: "These vessels are as alike in hull and engine dimensions as they can be built." The dimensions are very fully tabulated, and longitudinal and midship sections are given, together with photographs of the engines and full data of the motive-power machinery. The general dimensions are: Length, 174 feet; beam, 34 feet; depth, 22 feet 7 inches; displacement, 996 tons. The speed was to be 12 knots. The twin-screw engines are of the usual inverted, direct-acting, triple-expansion type, with cylinders 12, 18, and 28 inches in diameter by 18 inches stroke, and intended to develop 800 h. p. at 200 revolutions, with steam at 180 pounds.

With one exception the machinery of both vessels is the same. The original design called for two cylindrical boilers, 10 feet 6 inches in diameter and 10 feet 6 inches in length, with a total heating surface of 2,508 square feet and 60 square feet of grate-surface. Such boilers were placed in the Wheeling, but, at the request of the contractors, two water-tube boilers of a well-known make were substituted, with a heating surface of 3,620 square feet, and a grate-surface of 98 square feet.

The two gunboats, then, were exactly the same in every respect, excepting the boilers, and hence the conditions were admirably suited for purposes of comparison.

The data of the speed trials are very fully given in Mr. Bieg's paper, from which it appears that the conditions were very nearly the same for both vessels throughout. With a speed of 230 revolutions there was developed in one case 1,024 h. p. and in the other 1,051 h. p., and the speed of the Marietta was 13.02 knots, and that of the Wheeling 12.88 knots. In the Wheeling the Howden system of forced draft was used, while in the Marietta the air pressure was delivered direct to the ash pits. In the case of the Marietta an air pressure of 0.36 inches was used, against 0.78 inches for the Wheeling,—a natural consequence of the difference in grate-area.

So far as economy is concerned, the trials were distinctly favorable to the tubular boiler. According to Mr. Bieg, the quantity of coal consumed per hour, for the Marietta (water-tube boiler), was 2,300 pounds, and per i. h. p. 2.18 pounds, while, for the Wheeling, the corresponding values were 1,855.5 and 1.72 pounds respectively.

Mathematics for Engineers.

THE *American Electrician* for December contains an article by Mr. Townsend Wolcott with the above title, which contains so many good points that it should really be read entire, placing, as it does, the much-discussed subject of the practical value of mathematics in a clear and intelligent manner before the general reader.

As an example of the value of mathematical knowledge to the electrical engineer, for example, Mr. Wolcott says: "Any one who can read Maxwell's treatise understandingly, or who, not understanding all of it, can understand the more essential parts of it, will find that there is an immense amount of later literature that is only necessary because the great majority of those who study electricity cannot read Maxwell. Thus is the advantage of a mathematical method of treatment of physical science exemplified. After a quarter of a century of progress in that particular branch of science, which is phenomenal in its magnitude, we can go back to the beginning of that period and find much of what is commonly called new discovery, in the original edition of a treatise on that science."

Mr. Wolcott has many good words for some of the older mathematical treatises, and with some degree of justice he says: "It is more important to have a good book on mathematics than a modern one, and several modern books run to fads rather than to sober science.

"It is not merely the ability to calculate that constitutes the utility of mathematical knowledge to the engineer; it is also the increased capacity for understanding the natural phenomena on which the engineering practice is based.

"It is evident that the advantage to an engineer of understanding a work like Maxwell's is not lost, even if he never uses any of the mathematics for the purpose of numerical calculations. As long ago as the days of ancient Greece, Aristotle said: 'I find the young men who study mathematics quick and intelligent at other studies.'"

But, apart from the value of mathematical studies as a mental training, the modern engineer, whatever branch of the science he may pursue, will find mathematics one of the necessary tools of his profession. This is especially true as the increasing magnitude of modern undertakings carries him far beyond the range of the empirical methods by which former practice was so largely guided. Former experience is an excellent guide, when used with judgment, but it will not do to carry proportions deduced from empirical data very far from the limits of the original observations. When we have deduced the equation of a curve, we can construct the curve as far as we wish, but he is a bold man, having "the courage of his ignorance," who puts much confidence in a prolongation of any empirically-deduced curve beyond the range of the data on which it is based. Mathematics can never give you back more than is put into them, although they can teach much that would otherwise not be discoverable, and—what is often quite as valuable—enable false deductions to be detected. Almost as much depends upon the user as upon the method, and it has well been said that " figures will not lie, but that liars will figure."

The Purification of Feed-Water.

AMONG the papers presented at the convention of the American Society of Mechanical Engineers at New York, and forming a portion of the *Transactions* (Dec., 1897), one by Howard Stillman, upon a water-purifying plant, elicited much discussion, and demonstrated that the evils of boiler scale are appreciated by many steam users and engineers.

The plant described by Mr. Stillman is one installed by the Southern Pacific Railroad Company at Port Los Angeles, California, for the purification of feed-water to be used by the locomotives on that division. The plant is of interest because of the bad quality of the water treated, there being a large proportion both of carbonate and sulphate of lime and magnesia present, and also because it is a practical working installation in constant and continuous service, about which definite and trusworthy data are available.

The method employed consists of a double treatment of the water, with cream of lime and with carbonate of soda, the reagents being added successively in order to obviate the direct formation of carbonate of lime, which would otherwise occur by the combination of the two reagents with each other. The exact treatment of the water is determined by chemical analysis, after which the necessary amounts can be weighted out and used for each tank full of water. Two purifying tanks are used, the lime being added first, and the precipitated carbonates permitted to settle out, after which the liquid is passed to the second tank and the soda added.

The result is the removal of most of the carbonates and the conversion of the sulphate of lime and magnesia into sulphate of soda, the incrustating matter being reduced from nearly 40 grains per gallon to about 10 grains, and in practice the scaling in the boilers being practically stopped.

The question of the real advantage of purifying the water before feeding it into the boiler is one which elicited some discussion in connection with this paper, and, notwithstanding the objections made to " turning the boiler into a chemical laboratory," several engineers asserted that practical experience showed no harm from the addition of the soda directly to the feed-water in the boiler.

The real criticism of the method lies in the fact that it only partially acomplishes the desired result, leaving fully one-fourth of the scale-forming constituents still present, and reducing the quantity of solid matter in solution by only about twenty per cent. While this may be the best that can be done in purifying water in stock for locomotive water stations, as good if not better results can be accomplished by the use of high-temperature heaters and purifiers, precipitating the sulphates by the use of high-pressure steam in a closed heater.

THE BRITISH PRESS.

The Engineers' Strike.

THE contest between the Amalgamated Society of Engineers and the Employers' Federation reached an important stage in the proceedings when the conference early in December was held, and although the conference itself was without immediate result, so far as a settlement is concerned, yet it cleared the atmosphere to a very great extent by defining explicitly the positions and responsibilities of the two great parties to the struggle.

Nominally, the question at issue is that of the hours of labor; actually, it is the question of the control of management; and upon such an issue it is almost needless to say the sense of a great majority of the community is that the position of the employers, in standing out for the control of the management of their own establishments, is entirely just.

At the conference the question of the hours of labour was hardly mentioned, but instead, the employers submitted a number of propositions practically constituting their ultimatum, and as these propositions were such that the representatives of the men felt unable to accept without referring them to the rank and file of their organization, which has rejected them, the whole matter remains in suspense.

The employers propositions, in substance were these: I, entire freedom of employment to workmen and employers alike, union and non-union men to work in harmony together: II, the use of piece-work to be permitted to any employers or men who may desire it, the piece-rate to be fixed individually between employer and workman: III, the maximum overtime limit to be forty hours in any four weeks, except in case of breakdown, repair, or similar emergency work: IV, every workman to be paid according to his ability, the rate of wages being a matter of individual agreement between employer and employed, this being accompanied by a disclaimer of any intention on the part of the employers to reduce wages: V, no limitation to be placed on the number of apprentices: VI, the employers to have entire control of the manner in which machine tools shall be worked, including the right to encourage ability wherever found, paying the men according to their individual ability. To these was also appended a proposition for the avoidance of further disputes, providing that local employers receive local deputations of workmen, before the question is submitted to the central authorities of the respective organizations, and that, during such discussion, no stoppage of work shall occur.

It is to be presumed that these propositions fairly represent the position of the employers, and indeed, according to the *Times*, the employers offer them as final, holding that " they will not depart from them by one jot or tittle, and that they feel that the engineering trade of the country cannot be carried on unless they carry their point."

On the other side the workmen, as represented by the *Daily Chronicle*, see in these proposals a demand that they " give up every substantial safeguard that unionism has won during the last two generations," and " combination for all effective purposes is to be wiped out in the engineering trade." So far as the proposals are concerned the men have, by practically a unanimous vote, rejected them *in toto*.

Meanwhile the industries of the country are languishing, and foreign competition continues. This phase of the situa- is plainly expressed by the employers. In reply to the claim of the men that the eight-hour day should follow as the consequence of the increased efficiency due to improved machinery, the federated employers maintain that whatever gain is obtained from this source is necessary to assist in meeting the pressure of increasing competition. " Although the trade of this country is still supreme over that of other countries, the alarming extent to which orders are passing from us proves that our supremacy is rapidly diminishing. While our trade increases at a certain rate, that of almost every other civilized country is increasing in a far greater proportion, and, therefore, foreign competition cannot be dismissed as a bugbear."

The contention of the men is that they can follow their trade where it may go and, for example, find employment in the United States should orders go there. This side of the subject is clearly discussed in a letter to the *Times* from Mr. Angus Sinclair, the editor of *Locomotive Engineering*, of New York, himself well acquainted with industrial conditions on both sides of the Atlantic. After noting that within a single week fifty-eight locomotives for European railways had been placed with American builders, Mr. Sinclair refers to the idea of British workmen that they can follow their work to America and says that in such case:

"They will have to greatly change their ways to secure steady employment. Instead of an eight-hour day they will be glad to remain in the shop 56 to 60 hours a week," and, if employed on day work, "they will discover that they cannot push a file or wield a scraper with deliberate leisure," or they will find the foreman asking if they "intend working all the week on that two hours' job." Indeed, in the hustle of an American shop, the English mechanic soon gets rid of his deliberate movements and becomes as nimble as his companions, and before long is very glad to have an opportunity of tending several almost human automatic machines at piece-work rates, which pay him far better than day's work, for all the fact that he is a skilled workman. As the matter now stands, an early settlement, which it was hoped the conference would bring about, appears as far off as ever, and in the meantime the grasp of foreign competitors on trade, formerly wholly British, is becoming more and more firmly fixed.

That the men can win seems beyond the bounds of reasonable expectation; the principal danger lies in the possibility that they may cripple, not only their employers, but the industries of their country before a satisfactory conclusion is reached.

Unreasoning in the exercise of its strength, under a strange misconception of the relation of the workman to his employer, labor threatens to play the rôle of the blind Samson who may bring down the house above him in his fall.

Acetylene Mixtures.

EVER since the introduction of acetylene as an illuminant attempts have been made to dilute with other materials, This has been tried for two reasons—one to reduce the cost of the illuminating medium, and the other to enable it to be used in burners of larger opening than is possible with the pure acetylene. Practical difficulties have interfered with the use of acetylene as an enricher of ordinary coal or water gas, as the two illuminants will not combine readily, the mixture showing a tendency to separate and decompose. Air has been suggested as a diluent, but the obvious danger of keeping such a mixture in a gasholder has led to the devising of burners for the purpose of making the desired mixture at the point of ignition.

None of these plans has proved satisfactory in actual use, but now Professor Vivian B. Lewes, in a recent lecture, noticed in the *Gas World*, says that he has found methane to be a satisfactory diluent for use with acetylene. A mixture of 10 per cent. of acetylene, 30 per cent. of methane, and 60 per cent. of either hydrogen, carbon monoxide, or water gas. will give a light of 20 candles, and behave in every way like ordinary coal gas. He estimates that this mixture could be sold for 3s. 6d. per thousand, and the very high explosion temperature renders it entirely safe.

It is probable that acetylene will ultimately be used as an enricher for other gases, and probably the combination will be effected by some intermediate substance, like methane. It seems, however, as if a cheaper mixture than that above given might be made the vehicle for dilution and a greater economy realized; otherwise the competition of incandescent gas burners would be a serious factor in opposition to its success.

The Proper Study of Architecture.

PROFESSOR Aitchison, in his presidential address before the Royal Institute of British Architects, and printed in the *British Architect* (Nov. 5), gives utterance to some very wholesome truths about the study of architecture, which will well bear repetition and emphasis here.

Going straight to the root of the matter, he demands that architectural students learn architecture itself, not merely about architecture,—the art, not of imitating past work, but of creating present structures. To quote the words, not of an architect, but of an eminent American engineer referring to a similar subject, the student should be taught "what to do, and how to do it, rather than merely what has been done and who did it."

Says Professor Aitchison: "Looking at the enormous extent of knowledge required by an architect, and the almost antagonistic power of mind required, would it not be better to confine architectural teaching to architecture? As architecture is pre-eminently a constructive art, construction should certainly be its foundation,—the very last thing that would be thought of now, for the æsthetic architect would leave that to the builder and engineer. It seems ludicrous not to insist on the architect who is to build having such a knowledge of statics as to know the proper method of resisting the force of the wind, of water, and of earth, and the thrusts of arches, vaults, and domes. Statics would give us, too, important lessons in æsthetics, for it gives us the proper proportions of each part of a building when we know the height, the weight to be carried, and the strength of the material to be used. When these particulars are known and provided for, we may roughly say that we have only to accentuate the important part by mouldings, or have them adorned by the sculptor, to make them into architecture."

But it must not be forgotten that architecture is something more than a mere science; it is also an art; and, like all true art, to be successful it must affect the emotions as well as the reason. "Knowledge of the means used to produce emotions will not give the power to produce them, or else all the real critics of æsthetics would be poets, painters, sculptors, architects, or musical composers as well."

Here comes in the question of that undefinable quality which, for lack of a better name, we have called genius; and genius in architecture is not greatly different from that in any other branch of art. Many men may be taught the principles of statics and the laws of proportion, and many mediocre works will continue to be produced by careful students of such principles. The man of genius, too, will study, and profit by all that he has been taught, but he will put a new life into the dry bones which have been furnished him, and will render back far more than he has received from his instructors.

No man has yet suggested that art schools can create great painters, or that musical conservatories can produce masters of composition and harmony. The laws, so far as we know them, can be taught indeed, but the material to which the laws must be applied can come only from the inspiration of the user, or from the store-houses of the past. He is truly fortunate who possesses the true genius of art to originate genuine ideas for the present, and he should be doubly careful who, lacking original inspiration, must borrow from the works of those who have gone before.

Electro-Chemical Progress.

THE commercial application of electro-chemistry has been slower than most of the other developments of electricity, but it is now progressing at a rate which bids fair to make up for its former tardiness. An excellent view of the present state of electro-chemistry in England is given in an article by Mr. Bertram Blount in the *Electrician* (Nov. 12).

Electro-chemical processes have, until recently, labored under the disadvantage of suspicion. The capitalist has doubted the commercial practicability of methods demonstrated only on a laboratory scale, but the success which has attended electro-chemical methods in Germany and in the United States has removed much of this suspicion, and, as Mr. Blount remarks: "The conversion of the capitalist is the most significant achievement of the modern electro-chemist." Now, however, the barrier of timidity has been overcome, and "any electro-chemical process which can be shown to work well on a small scale, and is favourably regarded by an independent and competent consultant, will not go long a-begging. It will be taken up, not necessarily in England, but on the continent or in America, and a trial on a practical scale accorded to it. Should this prove successful, manufacturing in earnest will be begun, and no capital expenditure, however large, is likely to deter the true merchant-adventurer."

The oldest and largest branch of the art is the refining of copper, which must be sharply distinguished from the winning of copper from its ores by electrolysis. Electrolytic refining is a complete and colossal success, while the electrical reduction of the metal from the ore has not yet passed the experimental stage. Refining zinc by electrolysis is not likely to be a success commercially, because of the ease with which the metal can be purified by distillation; but, on the contrary, the electrolytic winning of the metal from the ore appears to offer many advantages, and several successful processes are on the market.

Sodium and aluminum are both well known as electro-chemical products, and the electrolytic production of alkali and chlorine is a branch of the art which is making daily progress.

Naturally the cheapening in the production of electricity is an important factor in the development of electro-chemical industries, and it is a noteworthy fact that the utilization of natural sources of power has resulted not so much in attracting existing industries as in the building up of new businesses depending upon the direct use of electric current without any intermediate conversion into force in motion.

"The present situation of electro-chemical industry may be summed up in a few words. The refining of copper is a thorough success, and its ultimate predominance is assured; the winning of zinc is about to come; the aluminum industry is on a firm and broad basis; sodium can be made cheaply, but wants buyers; soda and chlorine products are just rounding the corner, and their manufacture is being seriously undertaken; the coöperation of the capitalist in all reasonable enterprises has been secured. There has been much solid progress, and we may fairly look for further and substantial advances in the near future."

Diagram Accounts.

THE use of curves or irregular lines, plotted from numerical data, is a method of recording and investigating relations which has deservedly become popular in many branches of applied science.

Mr. John Jameson has recently applied the method of diagrams to the recording and comparison of cost accounts, and his paper before the recent meeting of the Institution of Mechanical Engineers, printed in *Engineering* (Nov. 12), contains some excellent points. Mr. Jameson truly says: "Few things are of more importance than a ready and accurate system of prime-cost accounts. By promptness and accuracy in ascertaining cost, the net result on the completion of every contract or piece of work done is at once brought clearly before the management; and the profit or loss shown serves as a guide for the acceptance or rejection of other contracts or other work. Usually the elimination of unprofitable orders, and the cultivation of profitable work directed by actual knowledge of cost, are alone more than sufficient to justify the comparatively small expenditure involved."

After enumerating the essential elements of a good cost system, including closeness to date, balance, detection of error, individual machine accounts, and separation of manufacturing from commercial trading, Mr. Jameson goes on to show how applicable the diagram system is for the purpose desired.

Every engineer is familiar with the manner in which the indicator diagram shows the relations between pressure and volume at every point of the stroke. "Precisely what an indicator diagram does in exhibiting the performance of a steam engine, a set of properly-constructed account-diagrams will do in disclosing the economic working of a manufacturing concern, in all that pertains to the actual manufacturing costs."

The diagrams proposed by Mr. Jameson are of several kinds, examples being given in the article to which reference has been made.

In the machinery-employment diagram the vertical ordinates represent the percentage of possible earnings of a class of machines, such as lathes, planers, or boring machines, the abscissas representing time, either weeks or months, so that the curve for any class of machines shows at once the proportional activity. As the lines interfere but little, several curves may be carried upon one sheet, and the general condition of the various earning elements of a shop revealed at a glance.

"The varying results of five or ten years' work can be exhibited upon a single sheet in a few lines, the direction of which indicates their import." By assuming a base line, the various fluctuations can be reduced to percentages. The several lines relating to machinery charges, establishment charges, wages, and store issues are then combined into a line of total costs. The interval between this line and the straight line denoting 100 represents the percentage of profit, where below the straight output line, and the percentage of loss, where the total costs exceed the output. Such a review furnishes data of great value for comparison with present operations, and fixes in the mind broad general principles of practical importance. A number of practical examples are given in the paper, showing the method of applying the system, together with conclusions drawn from the diagrams, modifications being readily made to meet the requirements of special conditions.

In concluding, Mr. Jameson says:

"One advantage in a good series of diagram accounts extending over a period of years lies in its showing that extreme over-pressure of work is too costly; extreme deficiency of work is ruinous; between them somewhere lies a mean, at which the highest profit may be made. It is important, therefore, that this mean should be ascertained, and then that it should at all times be as nearly as possible maintained. Good management should be judged, not by the mere profit made, but by the profit viewed in the light of the favorable or adverse circumstances under which it has been made."

This latter condition is one which is too often overlooked, and, indeed, without some graphical display of the work of past years and the conditions of present production, it is hardly possible to grasp fully the innumerable factors which enter into such a comparison.

Whatever the fundamental system of cost accounts used in an establishment, the reduction of the data thus obtained to the graphical form can hardly fail to render much more information than could possibly be gathered from them in tabular arrangement.

High-Speed Locomotives.

EVER since the first publication of the account, in various technical journals, of the excellent speed made by the Atlantic City express of the Philadelphia & Reading Railway during the summer of 1897, there has been more or less discussion in the columns of the British engineering journals upon the subject. In one or two instances the accuracy of the report was questioned, and the curious statement somehow got into print that in the United States the mile contained only 5,000 feet instead of the orthodox 5,280, while from numerous correspondents exclamations of incredulity were published.

For a time it looked as if the once almost interminable discussion of English versus American locomotives was to be reopened, and the old straw thrashed over once more.

This appeared the more unnecessary because no claim was made for extraordinary speed in itself, for this especial train, the published report rather dwelling upon the fact that the speed scheduled had been maintained during the entire summer without failure, and that this daily express train had not been late once.

Among the incredulous journals was *The Engineer*, in whose columns much of the correspondence upon the subject appeared. In its recent issues *The Engineer* (November 12 and 19, 1897) gives letters from Mr. Clement Stretton, an English engineer familiar with railway practice in the United States, together with an editorial reviewing the matter very fully. Although Mr. Stretton did not ride on the Atlantic City express during the last summer, he fully accepts the authenticity and accuracy of the report, especially as it agrees closely with figures obtained by himself from the same road under similar conditions in 1893.

At that time the entire run of 55½ miles was made in 55¼ minutes, the fastest mile being made in 44 seconds, or at the rate of 81.8 miles an hour, while the fastest mile of the past summer was made in 43 seconds—a rate of 83.7 miles an hour.

Commenting upon Mr. Stretton's letter, the *Engineer* says in its leading editorial (Nov. 19, 1897):

"We have done all that lies in our power for a long time past to arrive at the truth, and, although we cannot claim to have been very successful, we have ascertained that it is true that speeds are attained in the United States which are not attained here, and apparently cannot be attained."

The highest speeds attained in Europe are supposed to be those in the trials between English and French locomotives just after the last Paris Exposition, this being about 125 kilometers, or 77.5 miles per hour. After comparing the structural differences between the two types, the editorial proceeds: "The more carefully we examine the facts, the more difficult do we find it to explain why an American engine should run faster than an English engine. The only theory which promises to repay investigation is that the American locomotive is superior as a vehicle to the English engine."

There is one feature about the Reading engine which the *Engineer* apparently fails to note. The locomotive, which was a Baldwin Vauclain compound, was constructed with the Wooten boiler, common to most of the Reading engines, and possessed the superior steaming power which comes from the large fire-box and increased grate-area which that type permits. While we have no official data upon the subject, it is our belief, gained from a personal knowledge of Reading engines in general, and this Atlantic City train especially, that the high speed so successfully maintained was very largely due to the ability of the boiler to generate steam faster than the cylinders used it.

Electrical Traction.

An editorial in the *Practical Engineer* (Nov. 5) gives a very fair account of the present status of the mechanical traction problem for tramway service, especially in connection with the various local investigations made during the past few months by municipal commissions and borough engineers.

It seems to be generally admitted that Britain has not been so active as the continent or the United States in the adoption of mechanical substitutes for animal traction, and, this being the case, it is eminently wise to investigate the experience of others, and profit by their successes and failures. In Great Britain, as in other countries, there has been, and still is, a strong prejudice against the overhead trolley, but from many sources of information we are led to believe that this prejudice is weakening, in view of a more thorough knowledge of what has been accomplished elsewhere. Referring to this portion of the subject, the article in the *Practical Engineer* continues:

"In various parts of this country we have a few mechanical lines, but the proportion is exceedingly small. The cable, gas, electric conduit, overhead trolley, and steam have all their representative systems, but, from what one hears from day to day, it is clear that the battle of the systems is resulting in the victory of the overhead trolley, in spite of its objections. We believe that we are correct in saying that nearly every deputation has returned fully convinced of the serviceableness and economy of that system."

In this respect the various British municipalities are doubtless in much the same position as were many cities in the United States when the problem of electrical traction was presented to them. The overhead trolley, objectionable though it was on æsthetic grounds, offered the only solution of the question at all within the limits of commercial practicability. Those cities which adopted it have an economical, efficient, and rapid system of transit, accompanied, it is true, by the defacements which accompany, to a greater or less degree, the use of the overhead wires. Those cities which rejected it have until now struggled along with continually-increasing congestion of their main thoroughfares, and are now, in one notable instance at least, expending large sums for underground systems. The lesson from American experience England may readily learn, and, seeing the alternative, may choose intelligently. Overhead systems will do the work and do it well, and, where there is ample room, and where reasonable care is exercised, the unsightliness of poles and conductors may be very greatly diminished. Underground trolleys will do the work equally well, and without creating any eyesore, but only those who can afford the cost should consider them.

The Measurement of Wind Pressure.

In many engineering structures the force of the wind is an important factor to be taken into account in proportioning the strength of the various parts, and in some large work the wind stresses are among the greatest which the structure is called upon to resist.

Various methods have been devised for measuring the force of the wind, and, while some of these have been found acceptable for meteorological purposes, they have failed to give just the information which the engineer should have.

The Robinson cup anemometer, well known to all visitors to meteorological stations, is generally accepted as the most reliable apparatus at present in use, and the steady revolutions of the arms bearing the four hemispherical cups give a very fair measure of the mean velocity of the wind, especially when the instrument has been carefully calibrated on a sufficiently large whirling machine, and its individual coefficient determined. Even assuming the record of such an apparatus to be correct, however, it does not give the data in the form required for engineering purposes. The record of the Robinson apparatus shows the velocity in miles per hour during the period over which the observations extend. But this is only an average, and it is well known that the velocity is far from uniform, even over a small period of time; hence the maximum velocity must be some unknown quantity materially greater than the mean value thus determined.

Engineers, therefore, should be interested in a new form of anemometer, devised by Mr. W. H. Dines, a member of the Royal Meteorological Society, described and illustrated in *The Engineer* (Nov. 19). This apparatus is constructed somewhat on the same principle as that of the Pitot tube, used for measuring the velocity of water.

"The instrument may be briefly described as follows. The head consists of a vane, formed of a piece of tube with an open end, which is kept facing the wind, and into which the wind blows, while just below the vane is another and larger tube, perforated by several holes arranged in rings, the action of the air in blowing across which is to suck out the air from the inside. These two pipes are separately connected with soft metal pipes, which are led down to the recording apparatus wherever it may be placed."

The record produced by such an instrument is practically similar to that of other recording pressure gauges—*i. e.*, it shows all the fluctuations of pressure during the interval in which it is exposed, and also the suddenness and rapidity with which the changes of pressure occur. From such a record the engineer can obtain ample information concerning the forces to which any exposed structure may be subjected, and by preliminary exposures over a sufficient length of time the probable maximum pressures for any given locality may be determined.

Anemometers of this kind have been erected in various parts of Great Britain and the continent, as well as in India and Japan, and it is not unlikely that some form of apparatus constructed on this principle may supersede the rotating anemometer for meteorological observatories.

Fire Protection in London.

THE recent disastrous fire in London calls attention to the fact that the fire department of the metropolis has hardly progressed as rapidly as has the great city which it is intended to protect. In commenting upon the facts, *Engineering* (Nov. 26) says:

"The lesson is that we seem to know very little about fire protection in London, and that, the sooner we take up the matter, the better for all concerned, more particularly if we remember the rate at which the metropolis is growing in extent, the greater costliness of our structures, and their contents."

After referring to the condition of the London fire department at the time of the death of Mr. Braidwood, and the energetic efforts of Sir Eyre M. Shaw to develop its efficiency while he held office, the article referred to shows that the present force and equipment are barely equal to-day to what Sir E. M. Shaw thought necessary even in 1872, notwithstanding the enormous growth of the area requiring protection.

Continuing, the paper in *Engineering* says:

"But, after all, no matter how strong the brigade, and how well organized and handled, we shall continue to have our large fires until fire-*prevention* has been given the attention it demands. It would be absolutely impossible in twenty years' time, as to-day, and with the best aid from brigades skilfully handled, to prevent a fire spreading from one feather warehouse to another, if these two have a common area of only a few feet width, and under such circumstances have not even adopted the makeshifts of iron shutters to their windows. We shall even then not be able to prevent a fire which breaks out in the ground floor from destroying the whole building, if we simply have cast-iron columns, girder work, or so-called 'fire-resisting' construction, which has that quality only in name. If we have party-walls for warehouse property, why should these have to encounter the strain of iron work expanding and contracting from the fire? Why should they not be taken up higher than is requisite at present? In fact, there are a hundred questions which do not receive our serious attention, and to the neglect of which we must ascribe, in the first place, such conflagrations as the Cripplegate fire."

In all this criticism, the right keynote has been struck. Fire protection will always be necessary so long as the remains of earlier buildings exist and antiquated methods of construction are retained, and no efforts should be spared in all great cities to keep the fire protection up to the highest degree of efficiency, both in *personnel* and equipment. But fire-prevention is the theme which should be urged continually, and should ever be before the eyes of building inspectors and ordinance makers. The right of one man to imperil his neighbour's property should be denied or restricted wherever possible, and no more important function of the engineering profession exists than that of keeping the servant, fire, from becoming master.

THE CONTINENTAL PRESS

Compression in Steam Cylinders.

THE subject of clearance in steam engines, and the extent to which the losses due to clearance may be reduced by compression, is one which has been discussed and studied, both theoretically and experimentally, by many able engineers. As long ago as 1869 Zeuner enunciated the statement that, when the expansion is complete, a complete compression will entirely overcome the injurious effect of clearance. By a complete expansion Zeuner meant such a degree of expansion as makes the terminal pressure equal the back pressure; and by a complete compression that which causes the steam confined in the clearance space to attain the initial pressure.

Prof. Dwelshauvers-Déry discusses the subject in a very valuable paper in the *Revue de Mécanique* for October, and shows that, while the dictum of Zeuner may be theoretically true under the ideal conditions assumed, it may be shown to be in error when all the conditions actually existing in a working cylinder are taken into account and especially when cylinder condensation is considered.

If Zeuner's position is correct, the volume of the clearance space is a matter of no consequence whatever, and, instead of using all care and skill to reduce the clearance, engine designers might simply adjust the valves so as to give the proper degree of compression, whereby the desired result would be accomplished. The experimental tests of Hirn and Hallauer, as well as the practical experiences of engine builders, however, showed that the volume of clearance space does have a marked effect upon steam-consumption, even when high compressions are used, and, with but few exceptions, designers of steam engines continue to keep the clearance volume as small as is mechanically practicable.

In order to investigate this subject further, Professor Déry has made, at the University of Liège, in Belgium, a very careful series of experiments. These were made with the experimental engine at Liège, and it is interesting in this connection to quote Professor Déry's words:

"Hirn had many doubts, which his engine was powerless to solve. From this fact originated my own great desire to possess in a laboratory, with other instruments of precision, an experimental engine free from the trammels of factory demands and limitations, and flexible enough to be operated at any arbitrarily-selected points of cut-off and compression. To create such a laboratory capable of solving this and many other questions,—this was my dream, encouraged by Hirn. It may be a matter for astonishment that the realization required twenty-four years! To obtain the engine took eleven years of effort, nine years more were required to get the laboratory, and three years of experience to attain a degree of precision necessary to obtain satisfactory results. To-day, the mechanical tests made in our laboratory are such as to inspire thorough confidence in the results."

With this apparatus, and with a profound knowledge of the work of his predecessors, Professor Déry proceeded to investigate the behaviour of steam in a cylinder, and the results of his investigations, conducted in March, 1897, are given in the *Revue de Mécanique.*

The experiments included tests made with degrees of compression varying from zero to $\frac{4}{10}$ of the stroke, and indicator diagrams and heat measurements were taken with carefully-calibrated instruments, all conditions other than those under experimental investigation being kept practically constant. The results, which are both tabulated and plotted in curves, are most instructive, and demonstrate that the steam-consumption increased 57 per cent. when the compression increased from zero to $\frac{4}{10}$ of the stroke, and that this increase followed a regular law for the intermediate points of compression.

The cause of this loss is found in what Professor Déry calls the *anticipatory* condensation. The loss from the initial condensation of the live steam on entering the cylinder is greatest when there is no compression, and is diminished as the clearance space is filled with compressed exhaust steam; but the rate of this diminution is small compared with the loss which takes place by the condensation of the compressed exhaust before the point of admission is reached.

When the general loss from internal condensation is considered, the injurious effect of excessive clearance adds a factor which compression can only partially reduce, while Professor Déry's experiments reveal losses from this anticipatory condensation of the compressed exhaust which increase very rapidly with increase of compression. This action is also shown by the indicator cards, and verified by the concurrence of all the phenomena as the tests were repeated.

At first the compression acted to superheat the steam, the condensation beginning as the velocity of the piston diminished and showing its most energetic action when about 95 per cent. of the stroke was accomplished.

Professor Déry announces additional researches on the above lines, the results of which will be awaited with much interest.

A New Method of Testing Materials.

A SIMPLE method of testing metals in order to ascertain, not only the strength, but also the ductility and elasticity, was presented before the French Academy recently by M. Maurice Levy, and is described in *Comptes Rendus* (October 4.) The method, which is due to M. Fremont, consists in applying bending pressure to the test-piece, the latter being in the form of a prismatic bar, supported on roller bearings at each end in such a manner as to be free to yield to the action of the bending force applied at the middle point above. The section of the prism is reduced for a certain portion of its length, in order to limit the zone of yield, and the polished sides of the piece are marked with fine parallel lines, at uniform distances apart, and ruled at right angles to the length of the test-piece. When the piece is bent, these lines are distorted according to the deformation of the bar, and from the changed position of the lines the behaviour of the metal is ascertained.

By photographing the bent test-piece, usually on a magnified scale, a permanent record is made, and from such photographs comparisons between different specimens may be made in such a manner as to enable practical conclusions to be drawn very readily.

The ease with which the tests can be made, and the simple apparatus required, make the method particularly applicable for practical shop-use, where elaborate testing-appliances are not available.

Electrical Transmission in Workshops.

UNDER the title, "A Modern Machine Shop," a description is given in the *Zeitschr. des Vereines Deutscher Ingenieure* (October 23) of the works of Kolbern & Co. at Prag-Visocan in Bohemia, and, as the establishment is an excellent example of electrical transmission in shops, some of the details are of present interest.

The establishment is devoted to the manufacture of dynamo-electric machinery,—that is, to the production of moderate-sized machine work, the entire power of the engine being but 60 h. p. The machine shop is 72 feet by 200, divided longitudinally by a row of columns into two bays, each covered by an electric traveling crane, one of 3 and the other of 5 tons' capacity.

The entire power of the engine is used to drive a three-phase generator with a normal capacity of 50,000 watts. The current generated is divided into two portions, one of 200 volts' pressure for power purposes, and one of 100 volts, used for lighting. Each of the larger tools has its individual motor, and the special arrangements of the various tools show the care which has been given to the installation. In the case of a heavy 7-foot lathe, the motor is placed in the foundation, being, with its gearing, entirely enclosed and protected, a belt from its cone pulley driving the corresponding cone on the lathe. The high speed at which it is advisable to run the motors makes it necessary to gear down, and a general arrangement of self-contained motor and countershaft has been designed, the motor, gearing, and pulleys all being mounted upon one base in a form capable of being readily adapted for use with any machine tool.

The numerous small tools are grouped, and driven from a single line shaft, operated by its own motor, it being found better to do this than to use very small motors for the purpose.

The establishment contains at present twenty motors of various sizes, ranging in capacity from ¼ to 6 h. p. with a total of 38 h. p. The entire cost of these motors was less than the cost of three lines of shafting, each 200 feet long, with the hangers, couplings, and pulleys required by the old method of driving. It is claimed also that experience has demonstrated the running expense to be less with electric driving than with shafting, the cost of lubrication, wear and tear of belts, losses from journal friction, etc., all being eliminated by use of the electric system.

The Caillet Monorail.

VARIOUS forms of single-rail tramways have been devised from time to time, but most of these have failed to come into general use, mainly because their projectors attempted too much and brought the one-rail system into antagonism with the regular double-rail track. M. Caillet has been more modest, and for that reason may be more successful, as in his so-called "monorail" system, illustrated and described in *La Revue Technique* (November 10), he aims to produce only a portable and temporary tramway for industrial and agricultural purposes.

For such service the single track is especially suitable. There is no difficulty of maintaining uniform gauge or double grade, and the single track can be run quickly and conveniently in localities where a double track would be objectionable or difficult.

The cars for use on the monorail are very simple and convenient, consisting mainly of a pair of beams running parallel beneath the platform, and a single wheel between them at each end. The load is piled on the platform, with reasonable care in distribution, so as to "trim ship," and the horse is attached on one side, the harness being so arranged as to prevent tipping. A driver may ride on the car or walk beside, as occasion may indicate, and the platform may be replaced by box or barrow, according to the character of the load. Smaller cars for hand propulsion are made; some of the larger ones have a capacity of one-and-a-half tons.

The great facility with which this portable road can be put down and started in immediate operation is its principal claim to notice. Neither grades or curves offer material obstacles to its use, as it can be carried over rough country with ease. Three men can readily bend a single rail to any desired curve, and, as there is no importance attached to the exact degree of curvature and no companion rail to match, there is little trouble on that score.

Single-rail roads of this construction have found successful application in Egypt, Mexico, and the French colonies, as well as in the agricultural districts of France, while for military purposes there is no doubt of the availability of the system.

The Strength of Cylinder-Heads.

THE modern theory of the strength of materials makes it possible to compute with a reasonable degree of accuracy the strains and stresses in various portions of a structure when all the conditions are sufficiently well known to be taken into account. In many cases, however, it is not practicable to determine the conditions accurately beforehand, and recourse must be had either to empirical formulas or to constants deduced experimentally.

Sometimes also the correct theoretical relations may be obtained by judicious experimental investigations; such a case is found in the recent and very thorough experiments of Prof. C. Bach upon the strength of flat plates, such as the heads of steam cylinders, boilers, drums, and similar constructions.

Prof. Bach is already well known by his valuable treatise on the elasticity and resistance of materials, and these later investigations, published in the *Zeitschr. des Vereines Deutscher Ingenieure* (October 9, 16, and 23) are quite in the line of his former work.

The experiments were made on a large enough scale to be of direct practical value, the trial-cylinder being nearly 28 inches in diameter, and the general arrangement of parts reproducing fairly well the conditions of general practice. The stresses were applied by hydraulic pressure, and a rigidly-supported system of contact pins enabled accurate measurements of the bulging deformation to be made as the successive pressures were applied. Preliminary tests were made to determine the influence of changes of temperature upon the measuring apparatus, but, by maintaining nearly a uniform temperature in the apparatus, errors from this source were practically eliminated.

The tests were made at pressures progressing from one to twenty-five atmospheres (using the metric atmosphere of 1 kg. per sq. cm=14.22 lbs. per sq. in), and very full tables of the deflections under these conditions are given by Prof. Bach. The materials, having been previously tested for strength and elasticity, gave additional data for the verification of the theoretical treatment, so that the whole mass of results furnished ample material for mathematical discussion.

In this discussion Prof. Bach bases his computations upon the well-known formula for a beam fixed at both ends, and deduces from his experiments values for coefficients for heads of different shapes and materials. He takes occasion to oppose the theory of the late D. K. Clark that the resistance to bursting pressure varies as the thickness simply, and shows that his experiments sustain the general view, denied by Clark, that the resistance varies directly as the square of the thickness.

Altogether, Prof. Bach has not only added to the stock of knowledge concerning a special detail of construction, but has also shown how a series of experimental investigations should be conducted, and—what is still more important—how to use data thus obtained.

The New Faidherbe Bridge.

FRANCE has not been altogether successful in her attempts to develop her colonies, but it can hardly be said that this is due to neglect on her part, and the work which has been done and is still progressing in her possessions on the west coast of Africa is certainly worthy of encouragement, and should strengthen her position there materially.

We have already referred in these pages to the progress of the Senegal-Niger railway, and we now have to notice the new Faidherbe bridge, recently completed to connect the island of St. Louis with the main land. A very full description of this work is given in *Le Génie Civil* (October 23), with illustrations of the completed bridge and drawings of details.

The city of St. Louis, the capital of the French possessions on the Senegal coast, is situated on an island, which, since 1865, has been connected with the main land of Africa by a pontoon bridge across the wide arm of the Senegal river. This bridge owed its origin to General Faidherbe, then governor of the colony, and it has since been known by his name.

The constant increase in travel resulted, in 1892, in a decision by the colonial government to replace this primitive construction by an iron truss bridge of a permanent character, and this work, for which the contract was let in 1894, has now been brought to a successful completion.

The new bridge contains, in addition to a wagon-way and two sidewalks, a railway track of 1-meter gauge, the entire roadway being 7 meters in width.

The total length of the bridge is 506 meters (1,660 feet), divided into five stationary spans of 77 meters each, one swing draw of 71.5 meters, and one shore span of 43 meters; each being composed of a lattice truss with the bottom chord horizontal and the top chord a parabolic curve.

Owing to the peculiar conditions, the construction of the bridge involved some difficult problems. The piers were constructed by the use of compressed air in metallic caissons, which were sunk to a depth of 20 meters below the surface of the water before a suitable foundation was assured, the main pier for the swing truss being 9 meters in diameter. The depth of the water rendered the construction of false works difficult; hence, instead of being supported on piles, the trusses were assembled upon timber supports carried by floating pontoons anchored between the piers. This method was especially applicable, since the bottoms of the trusses were only about eight feet from the surface of the water, and the tidal differences small.

The general designs for the bridge, and the computations for the various members, were made under the direction of M. Résal, of the *Ecole des Ponts et Chaussées*, and, in spite of the climatic difficulties, the work was completed within the contract time by the builders, MM. Noguier and Kessler, of Argenteuil.

Metallography as a Method of Research.

A NUMBER of important and valuable papers were presented at the meeting of the International Association for Testing Materials at Stockholm, and among them may be noted the communication of M. F. Osmond, of Paris, upon "Metallography," or the study of various metals by the appearance of their etched sections. From this paper, as given in *Stahl und Eisen* (November 1), we make some extracts, referring the interested reader to the publication for further details.

Mr. Osmond ingeniously compares a chemical analysis of a metal, such as a steel or an iron, with an analysis of an organic substance, such as a bone, and maintains that, while such an analysis may convey some information, it is of small value without a corresponding knowledge of the accompanying physical structure.

Knowing as we do the different behaviour of metals of practically the same chemical composition, it must be admitted that anything which will enable structural differences to be studied is of great importance. The use of the etching of metal to show the texture of steel is by no means new, and, indeed, the waving lines upon a Damascus sword-blade are produced by a similar process; but Mr. Osmond proposes to systematize the subject into a complete science. Following out the analogy to living matter, the author divides the subject into anatomical, biological, and pathological metallography, dealing with the structure, the normal variations, and the ailments, so to speak, or abnormal variations of metals, as revealed by the physical behaviour of sections submitted to the action of corrosive agents, and studied under the microscope.

Mr. Osmond gives full credit to the pioneers in the study of the physical characteristics of metals,—Prof. Martens, Dr. Wedding, Prof. Guillemin, Dr. Sorby, and others,—but his own efforts to reduce the subject of metallography to a scientific system have added much to the independent work of his predecessors. The paper is illustrated with some admirable reproductions of micro-photographs of etched sections, showing very clearly the changes in structure caused by changed conditions of temperature and treatment.

Mixtures of Iron and Steel.

IT has occasionally been the practice of some foundrymen to add either to the cupola charge or to the molten cast iron in the ladle a certain proportion of steel scrap, it being claimed that stronger castings were thus produced. The *Moniteur Industriel* (October 23) describes some tests of such mixtures from the experiments of M. Vinsonneau, the castings consisting of a metal produced by adding 20 per cent. of bessemer or open-hearth scrap in the cupola.

The tensile strength of the product was found to be about 17,000 pounds per square inch, while a number of drop tests under various conditions showed a resistance to shock two to five times that of the cast iron without the addition of steel.

Castings from this metal also showed excellent quality for wearing surfaces, and M. Vinsonneau suggests its use for guide bars, large bearings, and the like.

The most important point to be observed is the thorough mixture of the materials, in order that the resulting product shall be as homogeneous as possible; for this purpose either the materials should be well mixed in the charge, or, better still, the melting should be performed in a furnace of the Pernot type with revolving inclined hearth.

Owing to its strength against shock, this mixture is well adapted for frame castings of heavy machinery.

Photographic Altitude Measurements.

THE use of exploring balloons and kites has mainly been devoted to meteorological investigations, but the necessity of determining the altitude attained by the recording instruments used in such work has resulted in the development of several independent methods of altitude measurement. Primarily the recording barometer is considered the altitude gauge, either for kite or balloon, the formula of Laplace in some one of its later revised forms being applied in the computation, together with the necessary instrumental corrections. In order to avoid entire dependence upon the barometer, the altitude has also been determined by measuring the length of cord in the case of a kite, using a measuring reel, and taking the angle from the reel to the kite, with proper correction for the length of the catenary.

At the session of the French Academy for October 26, M. Cailletet presented an account of another method, which is of value for several reasons. This method, described in *Comptes Rendus*, is based upon the automatic photography from the kite or balloon of two base stations, on the earth. The distance between the stations, and the focal length of the photographic objective, being accurately known, the altitude from which the photograph was taken can be found by simple proportion, from the distance between the images of the two base stations.

M. Cailletet has arranged such a device in connection with an auxiliary apparatus, by which the dial of an aneroid barometer is photographed upon the same film as the base stations; hence the altitude may be computed by both methods for the same instant. By having the film fed and the camera shutter operated automatically, at uniform intervals of time, a succession of images for different altitudes is obtained, and the correctness of the barometric indications may be verified by the measurement of the photographs.

A series of twenty-six photographs taken with this apparatus has been successfully worked up, and a similar apparatus is being designed to record the horizontal distance of the kite or balloon from a given base.

Among the practical results obtained by these experiments may be noted the verification of the barometric formula as used for the measurement of altitudes, and the general applicability of photography for similar measurements in other lines of work. A further communication from M. Cailletet will be looked for with interest.

Sewage Purification at Spandau.

THE city of Spandau, near Berlin, discharges its drainage into the river Havel, which in turn empties into the Elbe, and the number of cities located on both rivers below Spandau rendered it most desirable that the sewage should be purified before entering the stream. This subject was considered when the present sewerage system was planned in 1890, and since 1895 the purification plant has been constructed, and is now in successful operation. An excellent account of the method, including details of construction and cost, is given by Herr Pfeffer, in the *Gesundheits-Ingenieur* to which reference should be made for a full description.

The general method adopted is that of clarifying the sewage by use of a solution of chlorid of iron, which precipitates the albuminous matter and phosphoric acid, and also checks the formation of sulphuretted hydrogen and sulphid of ammonium, thus removing much of the foul odor. Further purification is effected by the addition of carbon in the form of finely-powdered lignite or brown coal, and a proportion of milk of lime is also added to assist in the precipitation.

The chlorid of iron solution is cheapiy prepared by treating bog iron ore with crude hydrochloric acid, and this solution is used in the proportion of fifty grams to the cubic meter of sewage, while about three times as much milk of lime is added. The lignite breeze is finely ground in a mill and mingled with water to the extent of 12 to 13 per cent., forming a liquid of about 7° Beaumé density; and this is added to the sewage in such quantity as to correspond to about 1.5 kilograms of coal dust to the cubic meter of water. Instead of chlorid of iron, the oxy-sulphate of iron may be used, in the proportion of 200-300 grams to the cubic meter of sewage. The liquid is then passed into suitable settling-tanks, from which the solid matter is drawn off from time to time by a system of suction chambers, and delivered to a filter press, where it is compressed into blocks suitable for burning.

It is found by experience that, for every 100 parts of solid matter added to the sewage for purification purposes, 160 parts are obtained in combustible blocks from the filter press, so that 60 per cent. of the matter has been abstracted from the sewage.

The plant at Spandau has been constructed in accordance with experience gained with similar methods used at Potsdam and at Leipzig, and in the latter city the investigations of Prof. Dr. Fr. Hofmann showed excellent results, so far as the sewage purification is concerned.

Some general idea of the cost of such a plant may be obtained from the actual figures given for this installation. At Spandau the sewage had to be elevated ten to twelve feet, in order to obtain the necessary fall, and this is included in the cost; but, as this is often the case elsewhere, these figures will also be of interest. The plant provides for a population of 75,000, allowing 6.5 liters per hour of sewage per head, and a dilution of 2.7 times, which corresponds roughly to 100 gallons per head every twenty-four hours. For this installation the machinery, including engines, boilers, centrifugal pumps, transmission, etc., cost £2,400 ($11,800), while the purifying portion, including buildings, came to £3,900 ($19,000); adding a miscellaneous account of about £200 ($1,000), the total cost is seen to be £6,500 ($31,800).

The Cost of Power.

THE industrial applications of electricity, and the necessity of generating current at as low a power-cost as possible, have led to renewed efforts to reduce the cost of obtaining motive power; especially when large units, such as are usually required for electric stations, are considered.

The *Zeitschrift für Elektrochemie* (October 5) contains an elaborate and important article by Herr Chr. Eberle, of Duisburg, upon the subject of power-cost, in which detailed comparisons are made between steam and gas-motors, the results being tabulated for units of 200, 400, 600, 800, and 1,000 h. p., for 365 days of 24 hours, and for 300 days of 11 hours.

For the 200-h. p. steam plant a compound engine is considered, having a consumption of 14.5 pounds of water per horse-power hour, while for the larger units a triple-expansion engine is considered, with a consumption of 11.7 pounds. The gas engines are supposed to be operated with power gas, generated in producers from coke, or anthracite, or both. In tabulating the various items, Herr Eberle has made careful allowance for interest and depreciation, and has based his costs upon well-ascertained prices of existing plants. For steam plants this was not difficult; for power gas motor plants the data obtainable from the Bâle waterworks plant and other similar installations furnished the best figures available.

As might be expected, the superior economy of the gas motors is most apparent with the higher cost of fuel, and, with coal at the lowest price taken by Herr Eberle,— *i. e.*, 6*s.* 6*d.* or $1.55 per ton,— the advantage is in favor of steam, while, with coal at 16*s.*, or $4.00, the gas motors show a higher economy.

Thus, with coal at the higher price the cost with steam, for a 200-h.p. plant, would be £6 5s ($30.30) per h. p. per year of 300 days at 11 hours per day, while for power gas under the same conditions the cost would be £4 15s ($23.30) per year. With coal at the lowest price of 6s 6d ($1.55) per ton, other things remaining the same, the computed costs are £4 4s ($20.30) and £3 17s ($18.60) per h. p. per annum for steam and gas respectively. It is only for very large units that the steam engine approaches the gas engine for economy, and this is doubtless due to the fact that for 1000 h. p. a single steam engine can be used, while a gas plant involves the use of five gas motors of 200 h. p. each, at least until the builders of gas engines are prepared to furnish larger sizes.

In this connection, however, we may add that one of the most important advantages of gas as a source of motive power has been overlooked. With the best modern producers it is by no means necessary to use a high-grade fuel, and, while the steam generator may be obliged to use a good quality of coal, the producer can be operated with low-grade slack, costing little more than the cost of transportation. With the latest improvements in gas engines, such as Herr Diesel has lately made public, and with the use of gas producers capable of utilizing low-grade slack and culm, the most economical steam engine will be badly distanced by the gas engine under any circumstances.

It has been contended by some engineers that good results cannot be obtained with gas engines when so poor a gas is used as that which is obtained from low-grade fuel, gasified in a producer without enrichment, but the experiments made in Belgium using the waste gases from blast furnaces directly in gas engines certainly prove the contrary.

According to a paper by Prof. Hubert, of Liège, in the *Annales des mines de Belgique* good results have been obtained. Thus ordinary gas engines have been satisfactorily operated with blast furnace gases analyzing:

Nitrogen	51.51
Carbonic Acid	16.78
Carbonic Oxid	23.98
Hydrogen and Hydrocarbons	1.07
Moisture	6.66
	100.00

Taking into account the calorific value of the gas, the efficiency of the engines averaged 13 per cent., which is very much better than could be obtained by burning such a gas under steam boilers and using the steam to operate steam engines.

When the capabilities of the gas engine are more thoroughly appreciated and a wider experience has been had with large motors and power-gas generators, the cost of power will undoubtedly be greatly reduced, in comparison with the above figures.

THE ENGINEERING INDEX

INTRODUCTORY

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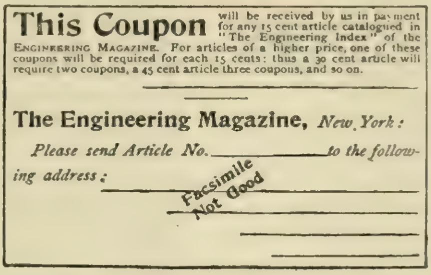

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American Architect. *w.* Boston, Mass.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila., Pa.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Journal. *m.* London
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m.* New York.
Chautauquan. *m.* Meadville, Pa.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.

Elektrotechniker. *b-m.* Vienna.
Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Engineer. *w.* London.
Engineer. *s-m.* New York.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, Tenn.
Engineering and Mining Journal. *w.* New York
Engineering Magazine. *m.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester. *bi-m.* May's Landing, N.J.
Fortnightly Review. *m.* London.
Forum. *m.* New York.
Foundry. *m.* Detroit, Mich.
Garden and Forest. *w.* New York.
Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glasers Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades' Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash , D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q* New London, Conn.
Journal Political Economy. *q.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc. of Eng. *b-m* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kan.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London
McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal
Mining Industry and Review. *w.* Denver, Col.
Mining Journal. *w.* London.
Mitt. aus d. Kgl. Tech Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. Stuttgart.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Science Review. *qr.* New York.
New Zealand Mines Record. *m.* Wellington, N. Z.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *q.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revue Technique. *b-m.* Paris.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerisches Bauzeitung. *w.* Zurich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Scientific Machinist. *s-m.* Cleveland, Ohio,
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J
Stone. *m.* Chicago, Ill
Street Railway Journal. *m.* New York
Street Railway Review. *m.* Chicago, Ill
Technology Quarterly. Boston, Mass.
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill
Western Railway Club, Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Zeitschrift für Lokomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.
Zeitschrift für Instrumentenkunde. *m.* Berlin.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Art Building.

New York's New Art-Academy Building. Edwin Emerson, Jr. Information concerning this building, with illustrations of the accepted design. 1200 w. Harper's Wk—Nov. 27, 1897. No. 16798.

Bank.

A Bank and Safe-Deposit Building. Illustrated description of the recently-constructed building for the Security Trust Company, of Rochester, N. Y. 700 w. Eng Rec—Nov. 6, 1897. No. 16350.

Birmingham, Eng.

The Architecture of Birmingham, England. Critical description of the buildings, old and new, with illustrations. 4800 w. Builder—Nov. 27, 1897. No. 16998 A.

Fireproofing.

Fireproof Buildings. Comments on the severe tests of recent fires on this style of structure, discussing the Manhattan Bank, New York, the fires at Pittsburg, Pa., and Detroit, Mich. Ill. 1200 w. Fire & Water—Oct. 30, 1897. No. 16260.

The Present Condition of the Art of Fireproofing. Peter B. Wight. Discussion of this question, with favorable comment on the use of burned clay. 2000 w. Br Build—Nov., 1897. No. 16890 C.

Foundations.

Cantilever Foundations for Small Buildings. Describes the unusual conditions existing in the city of New York, often making secure founda- a matter of great expense, and gives a plan resorted to in the case of steel structures of moderate size. Ill. 1600 w. Eng Rec—Nov. 27, 1897. No. 16878.

Healthful Construction.

Building Construction and Public Health. Peter Fyfe. Extract from an address under the auspices of the Glasgow Master Wrights' Assn. Deals with the essentials of a healthy house. 1400 w. Arch, Lond—Nov. 5, 1897. No. 16665 A.

Hotel.

Mechanical Features of the Hotel Touraine. Describes the general arrangement of rooms, electric wiring, and plumbing of a new Boston hotel. Ill. 2400 w. Eng Rec—Nov. 6, 1897. No. 16351.

Jail.

The Fulton County, Georgia, Jail. Part first consists of general description, giving floor plans, elevation and sections. 1200 w. Eng Rec—Nov. 13, 1897. Serial. 1st part. No. 16639.

Observatory.

A Famous Astronomical Observatory Built of Brick and Terra-Cotta. Illustrated description of the observatory given by Charles T. Yerkes, to the University of Chicago, and located at Lake Geneva. 1000 w. Brick—Nov., 1897. No. 16395.

Prison Construction.

The Steel Cell and Central Corridor System of Prison Construction. Illustrated description of method adopted in the Erie County Penitentiary at Buffalo, N. Y. 1100 w. Sci Am—Nov. 27, 1897. No. 16801.

Romanesque.

The Metropolitan Church of S. S. Rupert and Virgilius at Salzburg in the Romanesque Period. (Die Metropolitan-Kirche St. Rupertus und Virgilius zu Salzburg in Romanischer Zeit.) A valuable review of the development of the Romanesque school of ecclesiastical architecture with examples from various churches of southern Germany. 7500 w. Oesterr Monatscher f d Oeffent Baudienst—Nov., 1897. No. 16418 D.

Schools.

The American School House. Edmund M. Wheelwright. Part first compares the planning of German and American schools, and discusses sizes of rooms, light, ventilation, &c. Ill. 3300 w. Br Build—Nov., 1897. Serial. 1st part. No. 16889 C.

Tall Buildings.

The Tall Building from an American Point of View. A. D. F. Hamlin. A rejoinder to a previous paper by Prof. Capper, defending the tall building and showing the practicability of treating it in a satisfactory manner architecturally. The tall building is bound to remain in use, it is for the architect to meet the conditions which confront him. 3500 w. Engineering Magazine—Dec., 1897. No. 16896 B.

Town Hall.

The New Municipal Buildings of Suresnes. (Les Nouveaux Edifices Communaux de la Ville de Suresnes.) An illustrated account of the new town-hall of Suresnes, near Paris, with a description of the handsome electric-lighting plant. 1800 w. La Revue Technique—Oct. 25, 1897. No. 16426 D.

HEATING AND VENTILATION.

Columbus, Ohio, Depot.

Heating and Lighting Plant of the Columbus, O., Union Depot. Illustrated detailed description. The Webster steam-heating system is used, which involves the extreme use of the vacuum principle. 2300 w. Eng Rec—Nov. 20, 1897. No. 16729.

Dust Abatement.

Dustless Buildings. C. J. Woodbury. Describes a device for removing the annoying dust from the air in large buildings, caused by methods of heating and ventilation. 800 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16820 D.

Heat Calculations.

An Attempt to Systematize Calculations Where Heating is to be Accomplished Entirely or Partly by Air Introduced for Ventilation. H. Eisert. The object of the paper is to define the relations to each other of those conditions which must be considered wherever heating is to be accomplished by this method. 2500 w. Heat & Ven—Nov. 15, 1897. Serial. 1st part. No. 16702.

Hot Water.

Hot Water Heating of a Danbury, Conn., Business Block. Describes the heating of the Nichols Block. The overhead system of supply is employed, and the heater is placed on the first floor, there being no basement. Ill. 600 w. Eng Rec—Nov. 13, 1897. No. 16640.

Library Heating.

The Heating and Ventilating of the Library of the University of Illinois. James M. White. The system adopted is the "plenum" or fan system. The conditions to be complied with are given, with illustrated detailed description of work. 1800 w. Heat & Ven—Nov. 15, 1897. No. 16700.

Pipe Capacity.

The Capacity of Pipes to Convey Steam. E. C. Sickles. Describes some experiments made to determine friction of steam in wrought iron pipes, and discusses some of the results obtained. 1800 w. Sib Jour of Engng—Oct., 1897. No. 16863 C.

Residence.

Heating Residence of Thomas M. Turner, Esq. Illustrated description of a type of rural-residence heating quite prevalent in many parts of the United States. 700 w. Heat & Ven—Nov. 15, 1897. No. 16701.

Ventilation.

Pure Air in a Telephone Building. Describes the unusual means to accomplish this end, resorted to in the new telephone building in Cleveland, O. Ill. 700 w. Eng Rec—Nov. 27, 1897. No. 16881.

LANDSCAPE GARDENING.

Parks.

New Dangers to Public Parks. Editorial discussion of the various dangers which threaten parks. 1500 w. Gar & For—Nov. 10, 1897. No. 16549.

Trees.

Autumn Work Among the Trees. Editorial suggestions on tree-planting in the north. 1000 w. Gar & For—Nov. 3, 1897. No 16318.

PLUMBING AND GASFITTING.

Inspection.

Baltimore Plumbing Inspection. James C. Mitchell. Records the beneficial results in that city from the intelligent supervision established. 2200 w. Dom Engng—Nov., 1897. No. 16703 C.

Plumbing Ordinance.

New Plumbing Ordinance in Peoria, Ill. Given in full as a model for other cities. 6500 w. San Plumb—Nov. 1, 1897. No. 16327.

School House.

School-House Plumbing in Cold Climates. Describes a system installed at Red Wing, Minn., devised to meet all conditions of weather. Ill. 1100 w. Met Work—Nov. 20, 1897. No. 16713.

MISCELLANY.

Aberrations.

Architectural Aberrations—585-87 Broadway, New York. Remarks on the changes wrought in middle Broadway, N. Y., between Canal and 10th Streets, and its faulty architecture, with special criticism of the building named. 2500 w. Arch Rec—Oct.-Dec., 1897. No. 16334 C.

Address.

Presidential Address of Prof. Aitchison before the Royal Institute of British Architects. Considers the means of advancing the art and profession of architecture. Also discussion. 7800 w. Builder—Nov. 6, 1897. No. 16661 A.

Campanile.

Peruzzi's Campanile at Siena. W. P. P. Longfellow. Interesting account of the work of this noted architect of the Renaissance. Ill. 3200 w. Br Build—Nov., 1897. No. 16888 C.

Churches.

St. Mary's, Oxford. Arthur Edmund Street. Review of work by T. S. Jackson, with something of the history of the church. Ill. 2400 w. Jour Roy Inst of Brit Arch—October 14, 1897. No. 16675 D.

Ecclesiastical Architecture of Scotland. Review of a book by David MacGibbon and Thomas Ross, with critical remarks. Ill. 1800 w. Builder—Oct. 23, 1897. No. 16252 A.

Parochial Churches. Oswald J. Reichel. Extract from a paper read before the Devon and Exeter Architectural Society, England. Some of the peculiar architectural features of these churches, with interesting information. 1700 w. Builder—Nov. 13, 1897. No. 16721 A.

Classification.

A Proposal for Classifying Builder's Work. S. Flint Clarkson. Read before the London Architectural Assn. Considers why this is desirable and suggests classes to be made. Short discussion. 2100 w. Arch, Lond—Nov. 12, 1897. No. 16734 A.

Cliff Villages.

Account of an Expedition to the Cliff Villages of the Red-Rock Country, and the Tusayan Ruins of Sikyatki and Awatobi, Arizona, in 1895. J. Walter Fewkes. Reproduced from the Annual Report of the Smithsonian Institution for 1895. Descriptive. 4000 w. Brick—Nov., 1897. No. 16397.

Competitions.

Architectural Competitions. Russell Sturgis. A statement of a number of instances illustrating the failure to conduct competitions honorably, with discussion of the subject and of the essential conditions. 4500 w. Arch Rev—Vol. IV, No. VI. No. 16293 F.

Decoration.

Hall and Vestibule. Walter J. Pearce. Illustrated suggestions for the treatment of the walls. 1900 w. Plumb & Dec—Nov. 1, 1897. No. 16659 A.

The Interior Decoration of Churches. Ralph Adams Cram. Considers the elemental principles of church decoration, as drawn from the work of those ages when the Church was the dominant power in civilization. 3000 w. Arch Rev—Vol. IV, No. VII. No. 16867 F.

Materials.

Some New Building Materials. H. D. Searles Wood. Read at meeting of the Architectural Assn., London. Deals with asbestic and petrifite. 2400 w. Arch, Lond—Nov. 12, 1897. No. 16735 A.

Molding.

Esthetic Value of Molding and Profile. Joseph Venne. Read at Quebec Assn. of Architects. A brief review of the evolution of molding and profile as they appear in the monuments of different ages. 1100 w. Can Arch—Nov., 1897. No. 16770 C.

Mont St. Michel.

The Fortified Abbey of Mont St. Michel. Illustration and brief description of this wonderful and beautiful structure on the coast of Brittany. 1000 w. Eng News—Nov. 11, 1897. No. 16566.

Old English House.

Nevill Holt. Maud Cunard. Interesting illustrated description of an old English estate and some of its furnishings. 3500 w. Arch Rec—Oct.-Dec., 1897. No. 16333 C.

Painting.

See Civil Engineering, Miscellany.

Paris Bazaar.

The Paris Bazaar Fire. Edwin O. Sachs. Read at meeting of the London Architectural Assn. A careful discussion of this subject and of fire hazards in general, with the remedy needed to secure safety for large gatherings. Followed by discussion. 11000 w. Builder—Oct. 30, 1897. No. 16386 A.

Stairs.

Stairs. Fred T. Hodgson. Helpful suggestions on the design and construction of stairs. 5000 w. Nat Build—Oct., 1897. No. 16341 C.

Tarsney Act.

The Tarsney Act and the American Institute of Architects. Dankmar Adler. A discussion of the difficulties in the administering of this law. 1500 w. Inland Arch—Nov., 1897. No. 16668 G.

The Orient.

Oriental Architecture. Cyrus K. Porter. Traces the development of Saracen or Moslem architecture through its various stages, calling attention to its beauties. 8000 w. Stone—Nov., 1897. No. 16687 C.

Tools.

The Architect's Tools. Henry Rutgers Marshall. Discusses the tendency to over emphasize the importance of elevation drawings, and the means to be adapted to correct this fault. 4000 w. Arch Rev—Vol. IV, No. VII. No. 16868 F.

CIVIL ENGINEERING.

BRIDGES.

Arch.

Construction of a Forty-Foot Concrete Arch. C. H. Nicolet. Abstract of a paper presented at the Springfield meeting of the Illinois Society of Engineers and Surveyors. Descriptive. 1000 w. Eng Rec—Oct. 30, 1897. No. 16251.

East-River Bridge.

The New East-River Bridge Foundations. Describes the work on the New York side of this structure, especially the points that differ from the Brooklyn side. 2500 w. Eng Rec—Nov. 6, 1897. No. 16348.

Long Span.

Proposed 850-Foot Span Highway Bridge. Plans and specifications for a bridge across the Ohio River at Bellaire, O., were prepared and bids or designs for a cantilever and also for a suspension span invited. A comparison is made of the essential features of the two types available, with diagrams. 1500 w. Eng Rec—Nov. 27, 1897. No. 16875.

Old Bridge.

The Old National Bridge. Describes the bridge over the White-Water River, at Richmond, Indiana, which is soon to be replaced by a modern construction. Ill. 900 w. Pro of Purdue Soc of Civ Engs—1897. No. 16809 D.

Painting.

See Civil Engineering, Miscellany.

Railway Bridges.

Designs for Railway Bridges. Onward Bates. The subject is considered in a general manner. 13800 w. Pro of Purdue Soc of Civ Engs—1897. No. 16807 D.

Senegal.

The New "Faidherbe" Bridge at Saint-Louis. (Le Nouveau Pont Faidherbe à Saint-Louis.) A fully illustrated account of the new truss bridge across the Senegal, replacing the pontoon bridge connecting the island of the city of Saint Louis with the main land of Africa. 3500 w. 1 plate. Le Génie Civil—Oct. 23, 1897. No. 16422 D.

Suspension Truss.

The New Bridge over the Theiss at Tokay. (Die Neue Theissbrücke bei Tokaj.) Illustrated description of a suspended truss bridge on the cantilever principle recently completed at Tokay, in Hungary. The central span is 350 feet, and two side spans of 170 feet. 4500 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Oct. 29, 1897. No. 16411 B.

Toronto.

The New York Street Bridge, Toronto, Canada. Illustrated description of the type known as the "deck bridge." 300 w. Can Arch—Nov., 1897. No. 16771 C.

Trusses.

A Graphic Solution of Trusses. Fred Morley. A convenient method for determining the stress in any particular member of a roof or bridge truss. 2300 w. Pro of Purdue Soc of Civ Engs—1897. No. 16815 D.

CANALS, RIVERS AND HARBORS.

Breakwaters.

Breakwater Construction on the American Coast. Louis T. Schermerhorn. Extracts from a paper presented before the Engineers' Club of Philadelphia. Data of American experience and practice. 1000 w. Ry Rev—Nov. 13, 1897. No. 16655.

Bremen.

The New Harbor Works at Bremen and Bremerhaven. (Die Neuen Hafenanlagen in Bremen und Bremerhaven.) The official report of Herr Herbst, the chief engineer of the Austrian Department of the Interior, with plans of the docks and river improvements. 4000 w. Oesterr Monatschr f d Oeffent Baudienst—November, 1897. No. 16416 D.

Canal Outlet.

The Proposed Canal Outlet for the Birmingham (Alabama) District. W. M. Brewer. Describes a plan to connect this district with the Black Warrior River; a project of importance on account of the probable effect on freight rates. 500 w. Map. Eng & Min Jour—Oct. 30, 1897. No. 16262.

Dam.

The Moveable Dam on the French Meuse, (Eine Variation der Stauanlagen der Französischen Meuse) Description of the combined needle and shutter dam for the control of the level of the river Meuse in connection with the Eastern Canal of France. 2000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Nov. 1897. No. 16417 D.

Docks.

Extensions of Liverpool Docks. Report of the works committee of the Liverpool Docks and Harbor Board. 1800 w. Arch, Lond—Oct. 22, 1897. No. 16286 A.

Dredging.

Hydraulic Dredging: Its Origin, Growth and Present Status. W. H. Smyth. Read before the Technical Society of the Pacific Coast. Discussion. Reviews briefly the salient points in the progress of this art. 10,000 w. Jour Assn of Engng Socs—Oct., 1897. No. 16792 C.

Fremantle.

The Port of Fremantle. Report of the rapid advance in the work being carried out at this port in West Australia. 2000 w. Transp—Oct. 22, 1897. No. 16285 A.

India.

Cocanada Harbor. Jas. R. Bell. Letter with notes on condition, value, and a description of Cocanada Bay. 1400 w. Ind Engng—Oct. 2, 1897. Serial. 1st part. No. 16503 D.

Sea Lock.

See Electrical Engineering, Power.

Sea Walls.

Sea Defences. Richard F. Grantham. Read before the Society of Engineers, England. A study of the principles upon which works for the protection of property from the sea should be constructed. 3700 w. Ind & Ir—Nov. 5, 1897. Serial. 1st part. No. 16613 A.

Ship Canal.

A Ship Canal from the Lakes to the Hudson. A summary of the findings and conclusions reached and discussed in the report of Thomas W. Symons, on the question of this American ship canal. 1100 w. Ir Age—Nov. 4, 1897. No. 16325.

A Ship Canal from the American Lakes to the Sea. Main conclusions of the report of Thomas W. Symons, with examination of the report in some detail, showing how the conclusions have been reached. 2700 w. R R Gaz—Nov. 5, 1897. No. 16369.

From the Lakes to the Sea. Carl Snyder. An account of the inventions and devices that have now rendered feasible a great ship canal connecting the Great Lakes in the United States with the sea. Reviews the importance of the freight question, and of the invention of the pneumatic, quick-acting, high-lift lock, devised by Chauncey N. Dutton. Ill. 9500 w. Am Rev of Revs—Nov., 1897. No. 16244 C.

Will a Ship Canal from the American Great Lakes to the Atlantic Pay? Abstract of the report of Thomas W. Symons, with editorial review of facts concerning the enterprise, and letters from engineers. Ill. 15000 w. Eng News—Nov. 11, 1897. No. 16572.

Shore Protection.

The Protection of Shores against Encroachments of the Sea. E. L. Corthell. Devoted especially to the dikes and shore protection works of Holland, and showing how with skilful guidance the sea may be made to build up the shore instead of eating it away. 3000 w. Engineering Magazine—Dec., 1897. No. 16894 B.

Towing.

Electric Towing on French Canals. Illustrated description of systems used, and experiments made. 700 w. W Elect'n—Oct. 30, 1897. No. 16310.

Wharf Improvement.

Modern Wharf Improvements and Harbor Facilities. Foster Crowell. With illustrations and descriptions of dry docks on both sides of the ocean, as well as floating docks, and the details of docking and overhauling vessels. 4000 w. Engineering Magazine—Dec., 1897. No. 16897 B.

IRRIGATION.

Dam.

The Muchkundi Dam. Illustrated description of a concrete dam in India, forming an irrigation reservoir intended to store water for distribution in the plains at a lower level. 800 w. Engr, Lond—Oct. 22, 1897. No. 16272 A.

Drainage.

Drainage and Irrigation Works in Mexico. Describes works for "unwatering" and also for rendering land fertile by bringing water on to it. Gives brief outline of early work in this region. 1500 w. Nature—Oct. 21, 1897. No. 16279 A.

Gagings.

Stream Gagings. Clarence T. Johnson. Explanation of methods as used in Wyoming. Ill. 2300 w. Pro of Purdue Soc of Civ Engs—1897. No. 16811 D.

Water Lifts.

Water Lifts. The results of Mr. Chatterton's experiments on the merits of the various kinds of water lifts used in India for agricultural purposes. Also describes a simple and ingenious machine easily and cheaply constructed and adapted to any well. Ill. 2000 w. Ind Engng —Oct. 2, 1897. No. 16502 D.

MISCELLANY.

Address.

Address by Sir John Wolfe Barry before the Institution of Civil Engineers, London. After discussing details of business routine, the question of a meeting hall large enough to receive the entire membership is broached; as well as a new model room to receive the increasing collection. 5500 w. Engr, Lond—Nov. 5, 1897. No. 16644 A.

Altitude Measurement.

Apparatus for Measuring Altitudes. (Appareil Destiné à Mesurer les Hauteurs, &c.) L. Cailletet. An apparatus for determining the altitude of a balloon by photographing two points on the surface of the earth. A simultaneous photograph of the barometer is also taken for comparison and verification. 1200 w. Comptes Rendus—Oct. 26, 1897. No. 16435 B.

Beams.

A Diagram for Determining the Size of Beams of Rectangular Cross Section. John H. Gregory. Diagram with explanation of its use. 300 w. Eng News—Nov. 4, 1897. No. 16364.

Cement.

Notes on Cement-Mortar and Concrete. (Betrachtungen über Cementmörtel und Beton.) Prof. A. Martens. An investigation of the relation between the sizes of the particles and the binding power in concretes of various composition; with tables of tests and other data. 10,000 w. 1 plate. Mit a d Kgl Tech Versuchsanstalt—Part II, 1897. No. 16445 F.

Notes on the Manufacture and Properties of Blast-Furnace-Slag Cement. A. D. Elbers. Criticism of article by Henri Détienne, in the *Revue Universelle des Mines*. 1100 w. Eng & Min Jour—Oct. 30, 1897. No. 16263.

The Adulteration of Portland Cement. Editorial on the investigations of Messrs. Stanger and Blount, presented in a paper read before the English Society of Chemical Industry. 1600 w. Engng—Nov. 5, 1897, No. 16621 A.

Explosives.

The Use of Explosives for the Production of Natural Drainage. (Emploi des Explosifs à la Constitution de Drains Naturels.) Describes the success which has been attained in some instances by the use of explosives for loosening the ground and breaking up clayey, water-tight strata. 2000 w. La Revue Technique—Oct. 25, 1897. No. 16428 D.

Foundations.

See Architecture and Building, Construction.

Framework.

The Double Console. (Die Doppelkonsole.) Luigi Vianello. A mathematical investigation of the distribution of forces in a framework composed of two horizontal truss beams with vertical connection. 3500 w. Zeitschr d Ver Deutscher Ing—Nov. 6, 1897. No. 16408 D.

Hydraulic Obstruction.

The Law of Hydraulic Obstruction in Closed Streams. David Guelbaum. Describes method of investigation which led to the discovery of this law. Ill. 1600 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16828 D.

Ideal Column.

Theory of the Ideal Column. William Cain. Analysis, also giving an expression for the maximum deflection for a load very slightly exceeding that given by Euler's formula, and confirming that formula as a practical one within the usual limits. 3400 w. Pro Am Soc of Civ Engs—Oct., 1897. No. 16229 F.

Iron Protection.

Bridge Painting by Air Blast. Description of the apparatus and its operation used in painting the One Hundred and Fifty-fifth Street viaduct, New York. 1100 w. Eng Rec—Nov. 13, 1897. No. 16636.

Oil Paints for the Protection of Iron, Steel, and Wooden Structures. M. F. Linsday. The importance of a knowledge of the materials used is shown, and information concerning oils is given. 2200 w. R R Car Jour—Nov., 1897. No. 16565.

The Protection of Iron by Paint. Embodies the results of investigations and remarks on the properties of a good paint and the best method of applying it. 2800 w. Engr, Lond—Oct 22, 1897. No. 16269 A.

Mortars.

The Influence of Sea Water on Mortars. E. Candlot. Abstract translation. Reports the investigations made in the harbor of La Rochelle since 1856, with discussion. 3000 w. Eng Rec—Nov. 27, 1897. No. 16876.

Photo-Surveying.

Vertical and Horizontal Angles in Photo-Surveying. Fred Morley. Directions for platting a topographical map by means of the photographic surveying camera. 2500 w. Pro of Purdue Soc of Civ Engs—1897. No. 16813 D.

Recreation Pier.

The Third Street Recreation Pier. A description of the most important features, with drawings of this New York pier, which combines commercial uses and free popular pavilions that will benefit the residents of the crowded tenement districts. 2000 w. Eng Rec—Oct. 30, 1897. No. 16250.

Roads.

Roads. Francis V. Greene. An address given before the students of Union College, Schenectady, N. Y., and printed in the journal of the Massachusetts Highway Assn. Extract. Discusses the relation which roads bear to civilization, and defines some of the principles in accordance with which they should be constructed. 4800 w. Brick—Nov., 1897. No. 16396.

Society House.

The New House of the American Society of Civil Engineers. Brief history of the society with illustration and description of their new building, 220 West 57th St., New York. 2200 w. Ir Age—Nov. 25, 1897. No. 16859.

Stress.

Moduli of Elasticity for Compound Stress. W. Hendrick Hatt. Deals with the behavior of flat plates in flexure. 2000 w. Pro of Purdue Soc of Civ Engs—1897. No. 16814 D.

Surveying.

A Military Survey Made with a Bicycle. An account of use made of a bicycle fitted with a cyclometer, to obtain distances, and of a military pocket compass, for directions, in very rapid surveying. 500 w. Eng News—Nov. 4, 1897. No. 16362.

Tunnel.

A Submerged Tunnel. Abstract of a paper, "A Study of a Proposed Method of Building a Submerged Tunnel," by James Cowan Meem. Read before the Brooklyn Engineers' Club. Describes a method applicable to any case where the bottom is not of extraordinary depth and is of such a character as to admit of its being dredged. 1200 w. Eng Rec—Nov. 13, 1897. No. 16638.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

American Trade.

Thirty Years of American Trade. Michael G. Mulhall. The development of the last quarter of a century ; the American import trade, export trade, internal trade, and trade with various countries are discussed. 2700 w. N Am Rev—Nov., 1897. No. 16297 D.

British Colonies.

The Trade of the British Colonies. Michael G. Mulhall. A study of the development of the commercial relations based on statistics furnished by the Board of Trade, with conclusions. 2500 w. Contemporary Rev—Nov., 1897. No. 16524 D.

China.

The Foreign Trade in China in 1896. Editorial comment on the report on the foreign trade of China which issues from the Legation at Pekin, and gives a brief review of the whole of the trade and the conditions on which it depends. 1700 w. Engng—Oct. 22, 1897. No. 16276 A.

Competition.

The Competition of the American Iron Industry. (Der Wettbewerb der Amerikanischen Eisenindustrie.) An address by Herr Schrödter discussing the growth of the American iron production and the invasion of German foreign and home markets. 5000 w. Stahl und Eisen—Nov. 15, 1897. No. 16478 D.

The Failure of Legislation to Enforce Railway Competition. H. T. Newcomb. After reviewing the experience of the U. S. under the Interstate Commerce Law, it is shown that other countries do not consider railway competition the correct method of establishing rates. The true competition is that of actual trade, not transportation. 3000 w. Engineering Magazine—Dec., 1897. No. 16899 B.

The Importance of Supremacy in the Iron Trade. J. Stephen Jeans. Particularly discussing the relations of European countries to each other as competitors, based largely upon the report of the British delegation of the iron trade industry upon labor conditions on the continent. The greatest factor in favor of the continental producer is the lower cost of transport. 4500 w. Engineering Magazine—Dec., 1897. No. 16893 B.

See also Railroad Affairs, Miscellany.

Great Lakes.

The Commerce of the American Great Lakes. Charles E. Wheeler. Read at New York meeting of the Society of Naval Architects and Marine Engineers. The effects of cheap transportation by water and its future possibilities. 2800 w. Ir Age—Nov. 18, 1897. No. 16683.

Japan.

Foreigners in Japan. Remarks on the conditions of life of foreign residents, with summary of the main points of the new treaties and the influence of commerce and industries. 2500 w. Engng—Oct. 29, 1897. No. 16391 A.

Merchant Marine.

See Marine Engineering.

Prices.

Effect of the New Gold upon Prices. Charles A. Conant. Reviews the history of previous great additions, and their supposed effect, discusses the subject, and concludes that throughout the world there exists a capacity for the absorption of the new gold, which will therefore have no perceptible effect on prices. 5000 w. N Am Rev—Nov., 1897. No. 16296 D.

Shipyards.

See Marine Engineering.

Trade Commissions.

Commercial Missions in the Far East. Particulars of the methods and working of the Blackburn Commission to China, as gathered by a representative of the *China Mail* during an interview with F. S. A. Bourne, who represented the British Government. 2400 w. Engr, Lond—Oct. 29, 1897. No. 16511 A.

Trade-Marks.

Trade-Marks in Their International Relations. Francis Forbes. Reviews what has already been done to bring about international protection of marks, and the importance of the movement. 2000 w. Ir Age—Nov. 18, 1897. No. 16684.

Trade Relations.

Our Commercial Political Relation to England. (Unser Handelspolitisches Verhältniss zu England.) An address before the central industrial association of Germany discussing especially the British colonial-trade policy, and the best methods of promoting German commerce. 4500 w. Stahl und Eisen—Nov. 1, 1897. No. 16474 D.

CURRENCY AND FINANCE.

Austria-Hungary.

The Present Money Reform of Austria-Hungary. Otto P. Eberhard. Relates the experience of Austria, which twice drove her into bankruptcy, and finally brought about the reform which three years ago established the gold standard by the joint action of Austria and Hungary. 2500 w. Bankers' Mag, N. Y.—Nov., 1897. No. 16579 D.

Bimetallism.

Another Free Silver Fiasco. W. R. Lawson. Discussion of the recent agitation in England and the United States Commission. 5400 w. Bankers' Mag, Lond—Nov., 1897. No. 16523 A.

The Collapse of Bimetallism. Carl Schurz. Comments on the results of the special commission sent by the United States to Europe. 1300 w. Harper's Wk—Nov. 6, 1897. No. 16316.

The Fiasco of the Silver Commission. The history of the negotiations of the silver commission in London as outlined in a Parliamentary paper which was published in that city October 22, 1897. 7000 w. Eng & Min Jour—Nov. 6, 1897. No. 16387.

The Monetary Chaos. Robert Giffen. A discussion of the recent bimetallic agitation from an English point of view, stating the situation and the difficulties, and the principles which ought to guide. 13500 w. Nineteenth Cent—Nov., 1897. No. 16602 D.

China.

Financial Condition of China. Information from the report of British Consul Jamieson, on the "Revenue and Expenditure of the Chinese Empire," with comments. 1800 w. U. S. Cons Repts—Nov., 1897. No. 16521 D.

Coin.

Copper Cents. Interesting information of the most overworked coin made in the United States mints. 1600 w. Bos Jour of Com—Nov. 13, 1897. No. 16574.

Currency Reform.

A Proposition for Currency Reform. Explains the system suggested by John C. Bullitt, of Philadelphia, for the reform of the United States currency, and thinks the plan has much to commend it. 1400 w. Bradstreet's—Nov. 13, 1897. No. 16634.

Finance.

On the Financial Relations of Great Britain and Ireland. John Lubbock. Discusses the Report of the Financial Relations Commission, and aims to show that Ireland has been justly and even generously treated by Great Britain. 4500 w. Nineteenth Cent—Nov., 1897. No. 16603 D.

Permanent Currency.

Suggestion for a Stable Currency. E. J. Sanford. States the conditions of the United States currency at the present time, and gives suggestions for turning the entire banking business over to the national banks under certain rules and regulations. 1300 w. N Am Rev—Nov., 1897. No. 16299 D.

GOVERNMENT CONTROL.

Interstate Commerce.

The Long- and Short-Haul Clause Again. Comments on the decision rendered by the Supreme Court of the United States in the case of the Interstate Commerce Commission against the Alabama Midland and the Georgia Central Railroad Companies and others, arising out of complaints made by the citizens of Troy, Alabama. 1200 w. Bradstreet's—Nov. 13, 1897. No. 16635.

Municipal Ownership.

See Street and Electric Railways.

LABOR.

Employes.

See Street and Electric Railways.

Engineers' Strike.

One Aspect of the English Engineers' Strike. From the *Newcastle Herald*, England. Gives an account of the routine of life and methods of boarding the men on an old passenger steamer moored in the river near the Yarrow works. 1300 w. Engr, N. Y.—Nov. 1, 1897. No. 16339.

Profit-Sharing as a Remedy. Editorial discussion of the situation in England, brought about by this strike, and of Mr. Livesey's suggestion of profit-sharing. 2800 w. Engng—Nov. 5, 1897. No. 16620 A.

The Amalgamated Society and the Strike. Discusses the effect of the strike on English trade, the mistakes of unions, and related matters. 1800 w. Prac Eng—Oct. 29, 1897. No. 16516 A.

The Proposed Armistice. Editorial discussion of the present state of affairs in regard to the engineering strike in England. 2000 w. Engng—Oct. 29, 1897. No. 16390 A.

Great Britain.

See Railroad Affairs, Miscellany.

Labor Handling.

National Differences in Labor-Handling Methods. Hiram S. Maxim. The eastern portion of Europe is compared with the western and the western with the United States, the progress being from high individual skill and small production to highly improved tools and large production. Personal experiences in various parts of Europe are given. 3000 w. Engineering Magazine—Dec., 1897. No. 16891 B.

The Railway Problem and Labor. Robert P. Porter. Shows that if rates continue to decline, and properties to deteriorate in the United States, a reduction of wages will be absolutely necessary. Also urges an examination of the question and its effect on every class of labor. 2200 w. Ry Mag—Oct., 1897. No. 16605 C,

See also Mining and Metallurgy, Coal and Coke.

Strike Insurance.

Insurance Against Strikes. Editorial on a proposed scheme to indemnify manufacturers and others against loss through oppression from trades unions. 1600 w. Engr, Lond—Nov. 5, 1897. No. 16645 A.

Trade Unions.

The Amalgamated Society of Engineers, in England. History of the society, with details as to its general system of management, with discussion of the probable results of the struggle in which it is at present engaged. Also editorial. 4800 w. Engr, Lond—Oct. 29, 1897. No. 16509 A.

MISCELLANY.

Address.

The Relation of Technology to Mathematics (Die Beziehungen der Technik zur Mathematik). An address delivered by Prof. Stodola, of Zurich, at the International Mathematical Congress, 1897. The growing relation of theoretical computations to practical work is well shown by various examples in recent practice. 4000 w. Zeitschr d Ver Deutscher Ing—Oct. 30, 1897. No. 16407 D.

Education.

Past and Present Tendencies in Engineering Education. Mansfield Merriman. Presidential address at Buffalo, N. Y., meeting, showing the wonderful changes of opinion in regard to technical education, and urging that, general, education is more important than exclusively engineering courses. 4500 w. Pro of Purdue Soc of Civ Engs—1897. No. 16806 D.

Industrial School.

See Electrical Engineering, Miscellany.

Inventions.

Notes on the History of Invention in the 17th and 18th Centuries. (Beitrage zur Geschichte der Erfindungen im Siebenzehnten und Achtzehnten Jahrhundert.) An interesting contribution to the history of early patents in England and on the Continent. Serial. 1st part. 4000 w. Glaser's Annalen—Oct. 15, 1897. No. 16440 D.

Valuation.

See Mechanical Engineering, Miscellany.

Value.

Utility and Cost as Determinants of Value. Carl Stroever. A presentation of the writer's views which are opposed to the Austrian school, as expressed in a paper by Prof. Von. Boehm-Bowerk. 8000 w. An of Am Acad—Nov., 1897. No. 16685 G.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Bleaching.

The Application of Electrolysis to the Production of Bleaching Material. (Ueber die Anwendung der Electrolyse zur Darstellung von Bleichmitteln.) A description of the electrolytic bleaching method of Dr. Kellner, as applied by Messrs. Siemens & Halske. Two articles. 7000 w. Elektrochemische Zeitschr—Aug.-Sept., 1897. No. 16458 E.

Chemical Theory.

Contributions to the Theory of Electrochemistry. (Beiträge zur Elektrochemischen Theorie.) R. Mewes. Discussing the relation of the vibratory theory of chemical action to the corresponding phenomena of electrochemistry. Two articles. 6000 w. Electrochemische Zeitschr—Sept.-Nov., 1897. No. 16456 E.

Electrolysis.

A Mechanical Theory of Electrolysis Based on Maxwell's Hypothesis. (Mechanische Theorie der Elektrolyse auf Grund der Maxwell'schen Hypothese.) Prof. Weyde. Containing an interesting mechanical analogy to the supposed molecular movements in electrolysis. 2000 w. Elektrotechnische Zeitschr—Nov. 4, 1897. No. 16469 B.

Electrolytic Determination of Nickel and Cobalt in Steel. M. O. Ducru. Translated from *Comptes Rendus*. Discusses methods used. 1000 w. Am Mfr & Ir Wld—Nov. 12, 1897. No. 16625.

Experiments to Determine the Electrolytic Separation of Metals by Use of an Electric Meter. (Versuche die bei der Elektrolytischen Trennung von Metallen durch einen Elektricitätszähler zu Messen.) By closely regulating the strength of current various metals can be separated from a combined solution with a close degreee of accuracy. 4000 w. Zeitschr f Elektrochemie—Sept. 20, 1897. No. 16451 B.

The Electrolytic Separation of Nickel from an Aqueous Solution of its Sulphate or Chloride. (Ueber die Elektrolytische Abscheidung des Nickels aus den Wässerigen Lösungen seines Sulfats oder Chlorids.) Dr. F. Foerster. Discussing methods of obtaining a bright deposit of nickel of a greater thickness than has heretofore been practicable. 3500 w. Zeitschr f Elektrochemie—Sept. 20, 1897. No. 16452 B.

Electrolytic Alkali.

Industrial Notes on Electrolytic Alkali. John B. C. Kershaw. Brief discussion of the position and prospects of the three electrolytic soda processes. 800 w. Elect'n—Nov. 5, 1897. No. 16631 A.

The Electrical Equipment of Mathieson Alkali Works. J. R. Haskin. Confined to a description of the electrical machinery of the latest addition to the plants surrounding the great power house of the Niagara Falls Power Company. Ill. 900 w. Elec Wld—Nov. 27, 1897. No. 16847.

Electrolytic Apparatus.

Rhodin's Electrolytic System. Illustrated description of an apparatus for the extraction of metals, soda, potash and other alkaline salts, and also for the electrolytic production of a large number of other chemicals. 1100 w. Elec Rev, Lond—Oct. 29, 1897. No. 16380 A.

Galvanizing.

The Electrolytic Galvanizing of Iron. (La Galvanization Electrolytique du Fer.) A description of Wagner's method of coating iron with zinc by true galvanic action instead of dipping in a metal bath. 2500 w. Moniteur Industriel—Sept. 11, 1897. No. 16492 F.

History.

Electro Chemical Progress. Bertram Blount. Consideration of recent developments noting advances made and the tendency of thought. 2500 w. Elect'n—Nov. 12, 1897. No. 16718 A.

The Progress of Electro-Chemistry and Electro-Metallurgy During the Last Twenty-Five Years. Emile Andreoli. Sketches the progressive movement, and shows the immense amount of work accomplished. 4000 w. Elec Rev, Lond—Nov. 12, 1897. No. 16747 A.

Russia.

Electrolysis and Electro Metallurgy in Russia. (Elektrolyse und Elektrometallurgie in Russland.) Mainly a review of the commercial development of electrochemical industries in Russia since the Moscow exposition of 1882. 2500 w. Elektrochemische Zeitschr—Sept., 1897. No. 16457 B.

LIGHTING.

Advertising.

Electric Advertising. Description, with illustrations, of some of the effects secured by simple means. 1700 w. Dom Engng—Nov., 1897. No. 16704 C.

Arches.

Electric-Light Arches at Columbus, O. Engraving showing the appearance and details of construction, with explanation of how they came to be erected. 700 w. Elec Eng, N. Y.—Nov. 11, 1897. No. 16541.

Arc Lamp.

The Davy Enclosed Arc Lamp. Illustrated description of the lamp and its action. 600 w. Elect'n—Nov. 12, 1897. No. 16717 A.

Arc Lighting.

Twenty-Five Years Progress in Arc Lighting. R. E. Crompton. Historical Review. 3300 w. Elec Rev, Lond—Nov. 12, 1897. No. 16754 A.

Arcs.

Some Experiments on the Alternating-Current Arc. Charles F. Smith. A short description of experiments and appliances used. Ill. 600 w. Elect'n, Lond—Oct. 22, 1897. No. 16282 A.

Bradford Corporation.

Some Features of the Electricity Department of the Bradford Corporation, England. Alfred H. Gibbins. A short résumé of what has been done in Bradford in the adoption of certain beneficial arrangements with customers, such as free supply of lamps, hiring out of lamps and motors, inspection and repair. 1600 w. Elec, Lond—Oct. 29, 1897. No. 16376 A.

Conductors.

Devices for Supporting Large Conductors. S. H. Sharpsteen. Suggestions for wiring. 1200 w. Elec Eng, N. Y.—Nov. 11, 1897. Serial. 1st part. No. 16545.

Congressional Library.

Tests of the Illumination of the Rotunda in the Building for the Library of Congress. Cary T. Hutchinson. Describes the arrangements of the lights and the manner of testing. Ill. 1300 w. Elec Eng, N. Y.—Nov. 4, 1897. No. 16328.

Counter Electromotive Force.

Does the Counter E. M. F. Exist in the Arc? W. R. Bonham and Harold Almert. Records an experiment recently performed which throws some light on this subject. 600 w. Elec Eng, N. Y.—Nov. 11, 1897. No. 16542.

Efficiency.

The Factors Which Determine the Efficiency of the Alternating-Current Arc. William Beckit Burnie. An illustrated account of experimental investigations with results. 4900 w. Elect'n, Lond—Oct. 22, 1897. No. 16281 A.

Generators.

1500-k. w. Generators at the Station of the Allegheny County Light Company. P. H. Thomas. Describes the construction and gives other information. Ill. 2000 w. Elec Wld—Nov. 20, 1897. No. 16674.

Illumination.

European and American Practice. J. McGhie. Impressions very favorable to the electric development in England and France. 2200 w. Jour of Elec—Oct., 1897. No. 16548.

Incandescent Lighting.

Twenty-Five Years Progress in Incandescent Lighting. J. W. Swan. A brief review of the development. 1700 w. Elec Rev, Lond—Nov., 12, 1897. No. 16742 A.

Manchester, England.

Manchester, Eng., Electric Lighting and Traction. A brief and general report of the deputation recently appointed to visit the Continent for the purpose of inspecting Continental stations. 2500 w. Elec Rev, Lond—Oct. 29, 1897. No. 16379 A.

Projection.

Electrical Projection of Election Returns. Illustrated description of some of the arrangements made to display the returns at the recent election in New York. 800 w. Elec Wld—Nov. 13, 1897. No. 16551.

Scotland.

Cumbuslang Electric Lighting. Describes the installation at this small town on the Clyde. Ill. 2300 w. Elec Eng, Lond—Nov. 5, 1897. No. 16662 A.

Theatre.

The New Grand Theatre at Fulham. J. F. Tester. Describes the private electric-lighting installation in detail. 1300 w. Elec, Lond—Oct. 29, 1897. No. 16375 A.

York House.

Electric Lighting at York House. J. F. T. Describes a private electric-light installation in the premises which form the headquarters of the Junior Army and Navy Stores, London. 1400 w. Elec, Lond—Oct. 29, 1897. No. 16373 A.

POWER.

Alternators.

Alternator Design. J Fischer-Hinnen. From the *Elektrotechnische Zeitschrift.* An essay on the calculation of alternating current machinery, with special reference to the drop of pressure in the armature windings. Ill. 1200 w. Elec Eng, Lond—Nov. 5, 1897. Serial. 1st part. No. 16664 A.

A Universal Alternator for Laboratory Purposes. Henry S. Carhart. Illustrated description of the machine with reasons for adopting this design. 700 w. Am Elect'n—Nov., 1897. No. 16537.

Some Notes on the Parallel Running of Alternators. Sidney E. T. Ewing. Remarks on this subject of interest to engineers in charge of alternators connected in parallel. 2000 w. Elec Eng, Lond—Oct. 22, 1897. No. 16280 A.

The Design of Alternating Current Generators with Regard to the Drop in Tension. (Die Vorausberechnung von Wechselstrommaschinen mit Bezug auf den Spannungsabfall.) J. Fischer Hinnen. With diagrams of windings and tables of data, together with applications to practical examples. 7500 w. Elektrotechnische Zeitschr—Oct. 14, 1897. No. 16466 B.

Armatures.

Investigation of the Loss of Pressure in Armature Windings of Alternate Current Machines. Translated from *Elektrotechnische Zeitschrift.* Illustrated description of method. 900 w. Elec, N Y—Nov. 24, 1897. Serial. 1st part. No. 16837.

Batteries.

Twenty-Five Years' Progress in Secondary Batteries. L. Epstein. Slow but steady progress is shown. 3300 w. Elec Rev, Lond—Nov. 12, 1897. No. 16745 A.

Central Stations.

Twenty-Five Years' Developments in Central Stations. Robert Hammond. The review is limited to works in the United Kingdom. 4500 w. Elec Rev, Lond—Nov. 12, 1897. No. 16761 A.

Charges.

Low Tariffs versus Large Profits Examines the subject of charges for electrical energy, explaining the two opinions which exist and discussing the subject generally. 2400 w. Elec, Lond—Oct. 29, 1897. No. 16374 A.

Conductors.

Safe Carrying Capacity for Electrical Conductors. C. H. Sewall. Read before the Chicago Electrical Assn. Discusses the general physical laws and conditions which bear upon the subject. 3000 w. W Elect'n—Nov. 27, 1897. No. 16886.

Connecting Dynamos.

The Connecting of Dynamos for Simultaneous Operation. Reviews the various methods ig common use. Ill. 2700 w. Am Elect'n—Nov., 1897. No. 16539.

Cost.

See the same title under Mechanical Engineering, Power and Transmission.

Current Generation.

The Comparative Advantages of Steam, Gas, Air and Water-Power in the Generation of Electric Current. Brief discussion of the advantages and disadvantages of each. 1800 w. Elec, Lond—Oct. 29, 1897. No. 16378 A.

Distribution.

The Advantages of Electrical Distribution in Navy Yards. O. G. Dodge. Letter setting forth the advantages to be gained by the distribution of power in the navy yards by electricity from one central point. 1400 w. Elec Wld—Nov. 13, 1897. No. 16552.

The Distribution of Electrical Energy. C. H. Wordingham. Read before the Northern Society of Electrical Engineers, England. The writer favors the use of continuous currents for distribution in cities and towns of considerable size. 3300 w. Elec Eng, Lond—Nov. 12, 1897. Serial. 1st part. No. 16741 A.

The Distribution of Electric Energy in Paris. (La Distribution de l'Energie Electrique à Paris.) A discussion of the report of M. Bos to the Municipal Council of Paris in the matter of the applications of various corporations for franchises for electric power distribution. It is recommended in the report that the work be kept under municipal supervision and regulation. 3000 w. La Revue Technique—Nov. 10, 1897. No. 16431 D.

Drainage Plant.

The Electric Drainage Plant at the Memel Delta. (Die Elektrischen Schöpfwerksanlagen im Memel-Delta.) With plan and detailed account of the application of electric power for the operation of the scoop-wheel pumps for draining 45,000 acres of the delta of the Niemen on the Baltic Sea. 10000 w. Elektrotechnische Zeitschr—Sept. 30, 1897. No. 16464 B.

Dynamos.

Dynamo Troubles and How to Overcome Them. Percy Domville. Read before the Hamilton Assn. C.A.S.E. Hints as to the care of a dynamo and an idea of some of the accidents which are likely to occur, and the best way to repair them. 2800 w. Can Elec News—Nov., 1897. No. 16550.

Electric Locomotive.

See Mining and Metallurgy, Mining.

Electric Plant.

See Mechanical Engineering, Boilers.

Elevators.

Standards of Practice in Electric-Elevator Installation. P. R. Moses. With detailed descriptions of the latest type of the leading builders and a discussion of the essential features of successful design. Electric elevators are claimed to be the safest vehicles known to humanity. 4500 w. Engng Mag—Dec., 1897. No. 16900 B.

Factory.

Electric Power and Lighting Plant of the Mergenthaler Linotype Co., Brooklyn, N. Y. Illustrated detailed description. 2000 w. Elec Eng, N. Y.—Nov. 18, 1897. No. 16676.

Generators.

See Street and Electric Railways.

Haulage.

See the title Towing, under Civil Engineering, Canals, Rivers and Harbors.

History.

Twenty-five Years of Dynamo-Electric Machinery. W. B. Esson. Especially discusses the Gramme and the Von Hefner Alteneck machines, noting also the general development of designs. 2000 w. Elec Rev, Lond—Nov. 12, 1897. No. 16743 A.

Twenty-Five Years Retrospect on Primary Galvanic Batteries. T. E. Gatehouse. Historical review of the progress as recorded in the *Electrical Review* during the time named. 4000 w. Elec Rev, Lond—Nov. 12, 1897. No. 16-762 A.

Magnetic Lifter.

Great Plates Moved by Electricity. From the *Pittsburg* (*Pa.*) *Dispatch*. The work of the great magnets at the plate mill of the Illinois Steel Company is described. 1200 w. Bul of Am Ir & St Assn—Nov. 20, 1897. No. 16715.

Marine Machinery.

Electricity on Merchant Vessels. (Die Elektrizität an Bord von Handelsdampfern.) With details of the applications of electricity to lighting, hoisting, transmission of intelligence, &c., as used on modern ocean steamers. Two papers. 7500 w. Zeitschr d Ver Deutscher Ing—Oct. 30, Nov. 6, 1897. No. 16406 G.

Meters.

Meters versus Flat Rates. R. F. Schuchardt. Urging that central stations abandon the system of flat rates and sell their current by meter. 1200 w. Elec Eng, N. Y.—Oct. 28, 1897. No. 16233.

Mine Transmission.

The Electric Power-Transmission at Bleiberg. (Die Elektrische Kraftübertragung in Bleiberg.) The stream Nötschbach furnishes 285 h. p., which is transmitted electrically among four mines for pumping, hoisting aud lighting. Two articles, three plates. 10000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 16, 23, 1897. No. 16485 E.

Motor Car.

The Elieson Electric Motor Car. Illustrated description of the method of construction. 700 w. Elect'n—Nov. 12, 1897. No. 16719 A.

Motors.

Induction-Motor Design. Harris J. Ryan and J. J. Macomber. Analysis of the induction motor. 2500 w. Sib Jour of Engng—Nov., 1897. Serial. 1st part. No. 16865 C.

Theory of Constant-Speed, Direct-Current, Constant-Potential Motors. William Baxter, Jr. Considers the multiplication of formulæ for the calculation of motors a step in the wrong direction. Ill. 2200 w. Elec Wld—Nov. 27, 1897. No. 16846.

Testing Three-Phase Induction Motors—Transformer Connections—Full-Load Currents—Faults and How Located. W. T. Morrison. The subjects named are briefly treated in part first. 1000 w. Elec Eng, N. Y.—Nov. 11, 1897. Serial. 1st part. No. 16544.

Power Plant.

Power Plant on the Yadkin River, North Carolina. Illustrated description of plant being built by the Fries Manufacturing and Power Company, of Salem, N. C. 900 w. Fire & Water—Nov. 27, 1897. No. 16882.

Printing Machinery.

Electrically-Driven Printing and Binding Machinery. A. N. Rathbun. Describes and illustrates the plant of the S. S. McClure Company, publishers of McClure's Magazine. 1600 w. Am Elect'n—Nov., 1897. No. 16535.

Railroads.

See Railroad affairs, New Construction, and Street and Electric Tramways.

Rating.

Notes on Rating Electric-Power Plants upon the Heat-Unit Standard. William S. Aldrich. A second paper on this subject, the first having been read at the Hartford, Conn., meeting (May, 1897). Discusses progress shown in the past four years, &c. 3000 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16821 D.

Resistance.

Permanency of Resistance Coils. W. E. Ayrton. A comparison of results in order to determine the change that may have occurred in the resistance of the four coils used by Prof. Viriamu Jones in 1894. 500 w. Elec Eng, Lond—Nov. 5, 1897. No. 16663 A.

Rheinfelden.

The Great Electrical-Power Plant at Rheinfelden on the Rhine. Illustrated detailed description. 1300 w. Sci Am—Nov. 20, 1897. No. 16691.

Sea Lock.

Electric Plant for Operating and Lighting the New Sea Locks at Ymuiden. (Elecktrische Einrichtung zur Bewegung und Beleuchtung der Neuen Seeschleuse zu Ymuiden, Holland.) The lock gates are operated by winding-cable mechanism driven by electric motors. 1200 w. Glaser's Annalen—Nov. 1, 1897. No. 16444 D.

Transmission.

A Sierran Transmission. George P. Low. Full illustrated description of the plant of the

Blue Lakes Water Company in California, with information of the financial condition and persons interested. 9500 w. Jour of Elec—Oct., 1897. No. 16547.

Electricity in Cotton Mills. W. B. Smith McNally. Describes two plants, working under as nearly identical conditions as possible, one operated by rope transmission, the other by means of motors. 1300 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16827 D.

Swiss Transmission of Power Plants. Wilfrid L. Spence. Notes, principally on polyphase transmission plants, with a comparison between rival systems. 5000 w. Elec Eng, Lond—Nov. 12, 1897. No. 16739 A.

The Mechanicsville Schenectady (N.Y.) Power Transmission. Charles P. Steinmetz. Illustrates and describes some of the electrical features, giving reasons why they were adopted. 1800 w. Elec Wld—Nov. 13, 1897. No. 16555.

Transmission of Power by Two-phase Currents. (Transmission de Force par Courants Biphasés.) An account of the electric-power installation at the linen mills of Gluck & Co., Mulhouse, Alsace, in which very great uniformity of speed under variable load was demanded. A variation within one-fourth of one per cent. was maintained. 2000 w. Le Génie Civil—Oct. 30, 1897. No. 16424 D.

Twenty-Five Years of Transmission of Power by Electricity. Rankin Kennedy. The dynamo had just been designed, the progress is traced and the applications discussed. 2300 w. Elec Rev, Lond—Nov. 12, 1897. No. 16753 A.

TELEGRAPHY AND TELEPHONY.

Cable Capacity.

The Electrostatic Capacity of Long Cables. Walter J. Murphy. Letter to the editor criticising the Muirhead-Gott method, and describing method used by the writer. 800 w. Elect'n—Nov. 5, 1897. No. 16632 A.

Cable Insulation.

Insulator and Cable Testing, with Suggestions for New Apparatus. N. Monroe Hopkins. Describes some methods of insulator and cable testing, with suggestions which may prove of assistance to those who wish to experiment. Ill. 1200 w. Am Elect'n—Nov., 1897. No. 16536.

Earth Currents.

Electric Earth Currents Viewed Astronomically. Arthur E. Cotterell. Suggestions as to the probable cause of the important effects which are demonstrated to be due to these currents. 1800 w. Elec Rev, Lond—Oct. 22, 1897. Serial. 1st part. No. 16253 A.

Electric Measurements.

The Sensitiveness of the Telephone, and its Applicability to Electric Measurements. (Die Empfindlichkeit des Telephons und Seine Verwendung in der Messtechnik.) Devoted to an investigation of the precision which may be obtained by the use of the telephone in connection with a Wheatstone bridge for electric measurements. Two articles. 5000 w. Elektrotechnische Zeitschr—Sept. 30, Oct. 7, 1897. No. 16465 E.

Faults.

Improvements in the Localization of Faults in Submarine Cables by Null-Method Bridge Measurement. C. W. Schaefer. Examines sources of error, explains improved methods, and gives suggestions. 2400 w. Elect'n—Oct. 29, 1897. No. 16519 A.

History.

The Infancy of the Telegraph. From the *Dundee Advertizer*. Gives account of efforts for establishing communication at a distance, dating from the 15th century. 600 w. Elec, Lond—Oct. 29, 1897. No. 16377 A.

Twenty-Five Years of Telegraphic Progress. W. H. Preece. Considers instruments, apparatus, line construction, extent of plant, &c. 2000 w. Elec Rev, Lond—Nov. 12, 1897. No. 16759 A.

Twenty-Five Years' Developments in Telephony. J. E. Kingsbury. A review of the progress from its beginning. 3800 w. Elec Rev, Lond—Nov, 12, 1897. No. 16756 A.

Lighthouse Communication.

Electrical Communication with Lighthouses and Light-Vessels. Fifth and final report of the Royal Commission appointed to inquire what lighthouses and light-vessels it is desirable to connect with the telegraphic system of the United Kingdom by electrical communication. Abstract. 5000 w. Elect'n, Lond—Oct. 22, 1897. No. 16284 A.

Line Connections.

To Solder or Not to Solder. A. E. Dobbs and Charles H. Nohth. Gives an acccunt of test work in joints which resulted in the writers deciding not to solder joints, except where copper and iron are joined. Ill. 2000 w. Elec Eng, N. Y.—Nov. 18, 1897. No. 16677.

Magnetism.

See Mining & Metallurgy, Iron & Steel.

Microphones.

The Law and the Microphone. A résumé of the proceedings leading to the present situation of the suit of the American Bell Telephone Company vs. National Telephone Company. 4200 w. Elec Engng—Nov. 15, 1897. No. 16559.

Military Telegraphy.

Twenty-Five Years' Progresss of Military Telegraphy. R. von Fischer-Treuenfeld. Historical review. 2700 w. Elec Rev, Lond—Nov. 12, 1897. No. 16744 A.

Persia.

Telegraphs and Telephones in Persia. Interesting consular report giving history of these lines. 1500 w. W Elec—Nov. 20, 1897. No. 16772.

Submarine Telegraphs.

The Construction, Laying, and Repairing of Submarine Telegraphs. Charles Bright. Reports steady improvements in materials and details. 3800 w. Elec Rev, Lond—Nov. 12, 1897. No. 16757 A.

Telephone Service.

The Growth of the "Private-Branch Telephone Exchange" Service in New York City—An Interesting Evolution. Explanation of a change that has been made in the past year which is reported as highly satisfactory. Ill. 1500 w. Elec Eng, N. Y—Nov. 25, 1897. No. 16848.

Wireless Telegraphy.

Telegraphy Without Wires. (Die Telegraphie ohne Draht.) A paper by Dr. Müllendorff, discussing the various stages of the development of wireless telegraphy leading up to Marconi's practical application. 3500 w. Glaser's Annalen—Nov. 1, 1897. No. 16443 D.

MISCELLANY.

Accumulator.

A New Electric Accumulator. (Nouvel Accumulateur Electrique) The Digoine plate is composed of a network of leaden wires, soldered together to form a flat cage, which is stuffed with a paste composed of red lead. 1500 w. Le Génie Civil—Oct. 16, 1897. No. 16421 D.

America and Europe.

American Electrical Engineering in Europe. Robert P. Porter, in the Philadelphia *Inquirer*. Statistics and general information relating to the rapidity with which American electrical engineering is pushing its way. 2000 w. Elec Rev, N. Y.—Nov. 17, 1897. No. 16667.

Argon.

The Behavior of Argon in X-Ray Tubes. H. L. Callendar and N. N. Evans. Read before Section A of the British Assn., at Toronto. Report of investigations. 2500 w. Nature—Oct. 28, 1897. No. 16385 A.

Boston.

Electrical Boston Thirty Years Ago. Thomas A. Edison. An article prepared by Mr. Edison for a newspaper while he was a Western Union night operator in Boston, Mass. It gives a most interesting idea of the concerns making apparatus in Boston at the time, and of their specialties. 1800 w. Elec Eng, N. Y.—Nov. 18, 1897. No. 16678.

Coherer.

I. The History of the Coherer Principle. Oliver Lodge. II. The Practical Applications of the Coherer. A. C. Brown. III. On Compressional Electric or Magnetic Waves. Oliver Heaviside. IV. A Carbon Detector or Receiver for Hertz Waves. Frederick J. Jervis-Smith. A series of articles dealing with the theory and applications of the coherer to wireless telegraphy. 14300 w. Elect'n—Nov. 12, 1897. No. 16720 A.

Conductors.

The Molecular Theory of Conductors. (Molekular Theorie der Stromleiter.) A communication by Dr. Silberstein, relating especially to dielectrics, and poor conducting materials. 1500 w. Elecktrochemische Zeitschr—Oct., 1897. No. 16459 B.

Curve Tracer.

An Electric Curve Tracer. Edward B. Rosa. Illustrated description of apparatus for reducing the labor and increasing the speed of drawing electric curves, for delineating the forms and phases of periodic electric quantities. 2300 w. Elec Wld—Nov. 27, 1897. Serial. 1st part. No. 16845.

Cut Outs.

How Shall Electrical Apparatus Be Protected ? Joseph Sachs. States the conditions with which the device must comply, and discusses the two methods—the fusible cut-out and the magnetic circuit-breaker. 3000 w. Am Elect'n—Nov., 1897. No. 16538.

Diffusion Current.

Concerning the Current Generated by Means of Diffusing Gases. (Ueber dem durch Diffundierende Gase Hervorgerufenen Reststrom.) A discussion by Prof. Dannel of some former experiments of Helmholtz, with analytical and experimental investigation. Two articles. 4000 w. Zeitschr f Elektrochemie—Oct. 20, Nov. 5, 1897. No. 16455 E.

Direct Generation.

Electricity Direct from Coal. (Elektricität Direkt aus Kohle.) A general review of the efforts which have been made during the past ten years to accomplish the direct generation of electricity without the intermediate conversion into mechanical energy. Two articles. 9000 w. Zeitschr f Elektrochemie—Sept. 5, 20, 1897. No. 16449 E.

Dynamo Factory.

A Primitive Dynamo Factory and Power Station. An account of work done by the inexperienced. 1700 w. Elec Wld—Nov. 13, 1897. No. 16553.

Diagrams.

Diagram Accounts for Engineering Work. John Jameson. Read before the Institution of Mechanical Engineers, England. Describes a plan of diagram accounts, giving the requisites of the system. 2800 w. Engng—Nov. 12, 1897. No. 16738 A.

Electric Waves.

On the Use of the Interferometer in the Study of Electric Waves. G. F. Hull. Considers the use of the interferometer in the study of light; the analogy between light and electric radiation ; apparatus ; measurements, &c., with conclusions. 5000 w. Phys Rev—Oct., 1897. No. 16301 D.

Engraving.

Electric Engraving. (Elektrogravure.) A description by Dr. Langbein, of Rieder's new method of producing intaglio and relief modeling, such as medals, dies, etc., by the electric etching of the medal in contact with a reverse plaster model. 1200 w. Zeitschr f Elektrochemie—Sept. 5, 1897. No. 16450 B.

Field Magnets.

The Forms of Field Magnets and Their Influence Upon the Efficiency of Generators and Motors. William Baxter, Jr. A study of this subject and the means of obtaining the best results. Ill. 3000 w. Am Mach—Nov. 11, 1897. No. 16561.

Fuses.

Fuse Wires. R. S. McGowin. Gives the requirements of an efficient fuse, and discusses how to attain them, with further consideration of the subject. 1800 w. Sib Jour of Engng—Oct., 1897. No. 16864 C.

History.

Twenty-Five Years' Developments in Magnetism. Andrew Jamieson. Historical Review. 2000 w. Elec Rev, Lond—Nov. 12, 1897. No. 16760 A.

Twenty-Five Years' Progress in Electro-Therapeutics. W. S. Hedley. Reviews the work of this field and related subjects. 4800 w. Elec Rev, Lond—Nov. 12, 1897. No. 16749 A.

Induction.

The Theory of the Induction Coil. An examination of the mathematical theory of the induction coil as worked out by B. Walter, and of the experiments verifying the results. 1800 w. Elec Rev, Lond—Oct. 22, 1897. Serial. 1st part. No. 16254 A.

Industrial School.

Electricity at the New York State Industrial School. Joseph T. Freeman. Illustrated description of the electrical plant at the school in Rochester, N. Y., which supplies light and power, and furnishes the means by which practical information is given the boys in the care and construction of electrical machinery. 3500 w. Elec Wld—Oct. 30, 1897. No. 16290.

Instruments.

Electrical-Instrument Making During the Period 1872–1897. W. A. Price. The general course of progress is reviewed with brief notice of some important inventions. 2800 w. Elec Rev, Lond—Nov. 12, 1897. No. 16746 A.

Magnetic Shields.

Electromagnetic Phenomena in Connection with the Shielding, Exercised by Iron, of a Magnetic Field from One or More Conductors. James Russell. Gives experiments performed by the writer, with summary of conclusions drawn. 3300 w. Elect'n—Nov. 12, 1897. No. 16716 A.

Measurements.

Absolute Measurements. A. Gray. Traces the system of electrical measurements in its progress, and the benefits from the adoption of the absolute system of units. 2800 w. Elec Rev, Lond—Nov. 12, 1897. No. 16755 A.

Conductivity Measurements with a Direct-Reading Conductivity Bridge. Elmer G. Willyoung and H. P. Harth. Describes a method and apparatus devised by the writers, with a brief statement of its advantages. Ill. 2800 w. Elec Wld—Nov. 13, 1897. No. 16554.

Oils.

Dielectric Strength of Oils. Charles Proteus Steinmetz. Calls attention to an interesting fact relating to their disruptive strength. 500 w. Elec Wld—Nov. 20, 1897. No. 16673.

Phasometer.

The Theory and Application of the Phasometer. (Theorie und Anwendung des Phasometers.) A full analytical investigation of the conditions involved in the production of polyphase currents and a description of a new instrument for investigating them. 5 articles. 15000 w. Elektrotechnische Zeitschr—Sept. 16, 23, Oct. 7, 21, 28, 1897. No. 16462 H.

Resistance.

The Electrical Resistance of Metals. (Ueber den Elektrischen Widerstand der Metalle.) C. Liebenow. A valuable investigation, including the effects of temperature, and of composition, with curves, tables of constants, and other useful data. Two articles. 12000 w. Zeitschr f Elektrochemie—Oct. 20, Nov. 5, 1897. No. 16454 E.

Series Winding.

The Determination of the Series Windings for a Compound Dynamo. Lawford H. Fry. Sets forth a method which will give approximately the number of ampere windings required. 700 w. Elec Rev, Lond—Oct. 22, 1897. No. 16255 A.

Specialties.

Defects in Electrical Specialty Designing. H. N. Gardner. Calls attention to defects in appliances used in electric-light wiring, and the weak points in many specialties now being made. 1800 w. Elec Eng, N. Y.—Nov. 25, 1897. No. 16849.

Standard Cell.

The Reichsanstalt Type of Cadmium Standard Cell. W. Jaeger. From the *Elektrotechnische Zeitschrift*. Its particular feature is its very small temperature coefficient, enabling it to be used in most cases even for accurate measurements without account of its temperature being taken. 1200 w. Elect'n—Oct. 29, 1897. No. 16518 A.

Note on the Uniformity of the Cadmium Normal Cell. (Notiz über die Herstellung des Cadmium-Normalelements.) Prof. Jaeger. Showing that with the cadmium element a standard of voltage may be obtained and reproduced within an error of one ten-thousandth part. 1500 w. Elektrotechnische Zeitschr—Oct. 21, 1897. No. 16467 B.

Thermo-Electricity.

The Direct Transformation of Heat into Electrical Energy. (Sur la Transformation Directe de la Chaleur en Energie Electrique.) Marcel Deprez. An account of a new method of generating an electric current direct from heat ; based on the discovery by M. Guillaume upon the variation in magnetic properties, with heat, of certain alloys of iron and nickel. 1200 w. Comptes Rendus—Oct. 11, 1897. No. 16433 B.

Transformer.

Tesla's High-Potential Transformer. Explains the plan of winding the coils, the connection, and manner of using, stating some of the advantages. 900 w. Elec Eng, N. Y.—Nov. 11, 1897. No. 16543.

Transformers. James Swinburne. Tracing the history during the last quarter of a century, or more correctly, the developments during the last twenty years. 2400 w. Elec Rev, Lond—Nov. 12, 1897. No. 16751 A.

MARINE ENGINEERING.

Bazin Roller Boat.

M. Bazin's Roller Steamship. From *London Graphic*. Illustrated description of the boat and results of experiments made on the trip. 1200 w. Sci Am Sup—Nov. 27, 1897. No. 16802.

Coal Ports.

Coal Ports of Great Britain. An illustrated description of Newport, Monmouthshire. 2800 w. Ir & Coal Trds Rev—Nov. 12, 1897. No. 16786 A.

Contract Trials.

The Contract Trials of the U. S. Gunboats Wheeling and Marietta. F. C. Bieg. Dimensions with description of vessels and equipment, and report of trials. Ill. 3000 w. Jour Am Soc of Nav Engs—Nov., 1897. No. 16594 H.

Engineers.

American Naval Engineers. An examination of the scheme of Ira N. Hollis, as published in the *Atlantic Monthly* for September. 3000 w. Engng—Nov. 12, 1897. No. 16737 A.

Engine Efficiency.

Mechanical Efficiencies of Marine Engines. Bernhard A. Sinn. Explains what is meant by the term, and the ways of finding it. 1200 w. Mech Wld—Nov. 5, 1897. No. 16648 A.

Engines.

See Mechanical Engineering, Engines and Motors.

Experimental Tanks.

Experimental Tanks as an Aid to Marine Engineer and Naval Architect. W. F. Durand. Discussion of their application to experimental investigation, especially in regard to the resistance of ships and the performance of screw propellers. Ill. 3000 w. Marine Engng—Nov., 1897. No. 16531 C.

Floating Dock.

Floating Dock for Saint Paul de Loanda. (Dock Flottant de Saint-Paul-de-Loanda.) A full account of this structure built at Rotterdam for the Portuguese government and successfully towed to Africa; with plate of details and photographs of trials. 1800 w. 1 plate. Le Génie Civil—Oct. 16, 1897 No. 16419 D.

Frigate.

H. M. S. Leander. Investigations made in reference to the history of this vessel. 1800 w. Eng', Lond—Oct. 29, 1897. No. 16510 A.

Gunboat.

A River Gunboat. Illustrated description of the Melik, a twin-screw, shallow-draught gunboat built for the Egyptian government. 1500 w. Engng—Oct. 22, 1897. No. 16273 A.

Light-Draught Gunboats for the Nile Expedition. Description with illustrations of one of the new boats built in England for service above the cataracts. 1500 w. Sci Am—Nov. 20, 1897. No. 16692.

Lighthouses.

Feux-Eclairs or Lightning Flash Lights. John A. Purves. The object of the paper is to show how the system has evolved out of the old and existing order of lights and to point out that the system depends for its explanation and appreciation on common-sense reasoning. Ill. 2500 w. Engng—Oct. 29, 1897. No. 16392 A.

Lightships.

The United States Composite Electric-Light Vessels, Nos. 68 and 69. Illustrated description with dimensions of vessels which are to be stationed on the Atlantic coast of the United States at Fire Island, and the Diamond-Shoal off Cape Hatteras. 2400 w. Marine Engng—Nov., 1897. No. 16532 C.

Merchant Marine.

The American Merchant Marine. Charles H. Cramp. Read at a meeting of the New York Board of Trade and Transportation, Oct. 28, 1897. Presents facts showing the condition of the United States merchant marine, explaining why it is in its present situation, and suggesting the remedy. Gives a survey of English experiences. 4000 w. Sea—Nov. 4, 1897. No. 16338.

Marine Machinery.

See Electrical Engineering, Power.

Naval Architecture.

On the Advances Made in the Mathematical Theory of Naval Architecture During the Existence of the Institution. Edward J. Reed. Read at the International Congress of Naval Architects and Marine Engineers. Interesting historical review of progress. 15000 w. Jour Am Soc of Nav Engs—Nov., 1897. No. 16601 H.

Navies.

The Navies of the United States and Spain—A Comparison. Brief review of the two navies, showing Spain to possess a fleet not to be despised, which would enable her to maintain a fierce and destructive warfare. 1200 w. Sci Am—Nov. 6, 1897. No. 16352.

Police Boat.

Progressive Speed Trials of the Boston Police-Boat Guardian. Extracts from a paper by C. H. Peabody, read at the New York meeting of the Society of Naval Architects and Marine Engineers. Written with the object of inducing shipowners and shipbuilders to make progressive speed trials and present results. 600 w. R R Gaz—Nov. 19, 1897. No. 16694.

Power Transmission.

Auxiliary Engines and Transmission of Power on Naval Vessels. George W. Dickie. A presentation of the subject, with comparisons and conclusions, not aiming to show the superiority of any one system. 7200 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16826 D.

Revenue Cutters.

The Contract Trials of the U. S. Revenue Cutters Manning and McCulloch. C. A. McAllister. Describes these single-screw, composite vessels, and their machinery, with account of trials and other data. Ill. 3800 w. Jour Am Soc of Nav Engs—Nov., 1897. No. 16600 H.

Screw Propellers.

On the Formation of Cavities in Water by Screw Propellers at High Speeds. Sydney W. Barnaby. 2000 w. Jour Am Soc of Nav Engs—Nov., 1897. No. 16597 H.

Shipbuilding.

Shipbuilding as a Productive Industry in Great Britain. James McKechnie. With a discussion of the economic relation of the shipbuilding industry to other branches of trade, followed by illustrated descriptions of the leading British shipyards and their latest productions. 4500 w. Engineering Magazine—Dec., 1897. No. 16892 B.

Shipyards.

The Commercial Value of the Shipyard. Lewis Nixon. Discusses the relation of the shipyard to the arts of peace, showing its effectiveness to be indispensable to national prosperity. Presents the effect in England, and the importance of the subject in America. 5000 w. N Am Rev—Nov., 1897. No. 16295 D.

Society Meeting.

Annual Meeting of the Society of Naval Architects and Marine Engineers. Account of meeting with abstracts of papers. 3000 w. Eng News—Nov. 18, 1897. No. 16711.

Speed Trials.

Analysis of Speed Trials of Ships. William George Walker. Read before the British Assn., Toronto. Illustrates the method of analysis. 800 w. Engr, Lond—Oct. 29, 1897. No. 16515 A.

Some Notes on the Speed Trials and Experience in Commission of Our New Battleships. Philip Hichborn. From a paper read at the New York meeting of Naval Architects and Marine Engineers. The battleships referred to are the American ships Indiana, Massachusetts, Oregon and Iowa. 1300 w. R R Gaz—Nov. 19, 1897. No. 16693.

Steamship.

Newest American-Built Steamship for Hawaiian Islands Trade. Illustrated description of the "Helene" built by the Union Iron Works of San Francisco, Cal. 800 w. Marine Engng—Nov., 1897. No. 16530 C.

Steamboat Lengthening.

Lengthening a Hudson River Steamboat. Illustrated description of the addition of 30 feet to the steamboat New York. 1800 w. Sci Am—Nov. 27, 1897. No. 16799.

Stern Wheeler.

Pittsburg and Cincinnati Packet-Line Stern-Wheel Steamer Queen City. Bert L. Baldwin. Illustrated detailed description. 2500 w. Marine Engng—Nov., 1897. Serial. 1st part. No. 16533 C.

Submarine Work.

The Floating of the Russian Cruiser "Rossia." (Le Relèvement du Croiseur "Rossia.") An account of the manner in which, by very skilful submarine work, divers were successful in floating a 10,000 ton warship, which had run aground in the Neva. 2500 w. Le Génie Civil—Oct. 16, 1897. No. 16420 D.

Torpedo Boats.

The Contract Trial of the U. S. Torpedo Boat Foote. C. N. Offley. Description of vessel and equipment, with account of trial. Ill. 2500 w. Jour Am Soc of Nav Engs—Nov., 1897. No. 16595 H.

The Machinery of Vessels of the Destroyer Type. Brief review of the problem of fast ocean travelling, and of the engines of torpedo-boat destroyers. 2200 w. Mech Wld—Oct. 22, 1897. Serial. 1st part. No. 16246 A.

The U. S. Torpedo Boat Rodgers. W. M. Parks. Description and results of trials made with this boat, which is a sister boat of the Foote. Report of accident during trial. 1000 w. Jour Am Soc of Nav Engs—Nov., 1897. No. 16898 H.

Torpedo-Boat Design and the New Torpedo Boats of the United States Navy. H. G. Gillmor. Read at New York meeting of the Society of Naval Architects and Marine Engineers. Reviews the development of torpedo-boat construction, and discusses the requirements of sea-going and of coast-defence torpedo-boats. Ill. 6200 w. Eng News—Nov. 18, 1897. No. 16708.

Training Vessel.

The New Training Vessel for the Naval Academy. Robert G. Skerrett. Illustrated description of vessel to be built, for which the United States Congress has granted $125,000. 800 w. Harper's Wk—Nov. 27, 1897. No. 16796.

Valve Gear.

The Stevens Valve Gear for Marine Engines. Andrew Fletcher. Two letters on the origin and introduction of this form of valve gear, with drawings. 2000 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16825 D.

Warships.

The British Mediterranean Fleet at Trieste. (Die Englische Mittelmeerflotte in Triest.) An interesting description of the technical points of the British warships in the harbor of Trieste, from an Austrian point of view. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 15, 1897. No. 16408 B.

Two New German Battle Ships. (Zwei Neue Deutsche Panzerschiffe.) Illustrated description of the launch of the battleship Friedrich der Grosse, at Wilhelmshaven, together with an account of the armored cruiser Fürst Bismarck. 2500 w. Stahl und Eisen—Oct. 15, 1897. No. 16472 D.

Water-Tube Boilers.

The Status of the Water-Tube Boiler in the American Marine. W. M. McFarland. With comparative description of the leading types now in approved use, and a discussion of the policy of the United States Navy. The delay in introducing water-tube boilers was due to prudence in making innovations while the new navy was being created ; not to ignorance or lack of appreciation. 5000 w. Engineering Magazine—Dec., 1897. No. 16895 B.

Use of Water-Tube Boilers in the Mercantile Marine. Albert Edward Seaton. Discusses the advantages, enduring power, cost, design, &c., and gives tabulated statements, particulars of the different kinds of boilers, their weights, &c. 3400 w. Jour Am Soc of Nav Engs—Nov., 1897. No. 16596 H.

Water-Tube Boilers. Fred J. Rowan. Abstract of a paper read before the Institution of Engineers and Shipbuilders in Scotland, on Oct. 26, 1897. Calls attention to some historical points connected with water-tube boilers, gives a chronological classification of the designs and discusses circulation, heating surface and combustion. 4000 w. Eng's Gaz—Nov., 1897. No. 16337 A.

Yacht.

Steam Yacht for the English Ambassador at Constantinople. Illustrated description of this vessel built by the Thames Ironworks Company. 500 w. Engr, Lond—Nov. 12, 1897. No. 16731 A.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Bagasse Furnace.

Furnace for Burning Green Bagasse. (Four à Bruler la Bagasse Verte.) A description of the furnaces used in the sugar plantations of the island Reunion, for burning the crushed cane for generating steam. 1800 w. Le Génie Civil —Nov. 6, 1897. No. 16425 D.

Boiler Rules.

Lloyd's Register New Boiler Rules. A discussion of a recent concession made by Lloyd's Register and its appreciation by marine engine builders, with other changes of rules. 2000 w. Engr, Lond—Nov. 5, 1897. No. 16642 A.

Boiler Setting.

A Boiler Setting. G. W. Bissell. Method for supporting a horizontal return-tubular boiler is described. Ill. 250 w. Trans Am Soc of Mech Engs—December, 1897. No. 16829.

The Setting of Horizontal Tubular Boilers. The paper is the result of conversations with designers of boilers, with masons making a specialty of boiler settings, and with operating engineers and firemen, together with observation. Ill. 4000 w. Power—Nov., 1897. No. 16289.

Crown Bars.

Crown Bars for Locomotive Boilers. From *The Locomotive*. Deals with the proportion and arrangement of crown bars in locomotive boilers, giving some of the principles that have been found satisfactory in practice. Ill. 2800 w. Prac Eng—Nov. 12, 1897. No. 16774 A.

De Laval Boiler.

The De Laval Steam Boiler. Illustrated description. K. Sosnowski, in *La Nature*. The particular characteristics are high pressure and automatic operation and regulation. 1200 w. Sci Am Sup—Nov. 27, 1897. No. 16803.

Electric Plant.

The Steam-Boiler Question in Electric-Power Plants. (Die Kesselfrage der Elektricitätswerke.) A discussion of various types of steam boilers with regard to their applicability to electric-power plants. 7500 w. Elektrotechnische Zeitschr—Sept. 30, 1897. No. 16463 B.

Fire Engine.

A New Fire-Engine Boiler. Illustrated description of a new departure in the construction of this class of fire apparatus, the invention of Charles H. Fox, of Cincinnati. 1500 w. Fire & Water—Nov. 27, 1897. No. 16883.

Flue Swaging.

Pneumatic Flue-swaging Machine—Pennsylvania Railroad. Illustrated description of the machine and its operation. 900 w. Ry Mas Mech—Nov., 1897. No. 16343.

Grate.

The "Persian Sword" Grate. (La Grille à Lames de Persiennes.) The "Persian Sword" grate obtains its name from the shape which is given to the air and gas jets by the shape of the openings between the bars ; a thorough mingling of the burning gases is obtained. 1200 w. La Revue Technique—Oct. 25, 1897. No. 16427 D.

History.

Twenty-five Years Progress in Boiler Making. W. H. Booth. The progress has been almost wholly in workmanship rather than in principles. 3000 w. Elec Rev, Lond—Nov. 12, 1897. No. 16750 A.

Repairs.

How to Make Heavy Repairs on the Locomotive Boiler. Henry J. Raps. Suggestions for the inspection and repair of boilers. Ill 2500 w. Loc Engng—Nov., 1897. No. 16319 C.

Scale.

Soda Ash as a Boiler Purge. Considers this the cheapest and least objectionable of the chemical compounds used for purification, and explains its action and how it should be used. 1000 w. Ry Mas Mech—Nov., 1897. No. 16342.

Smoke.

A Scale for Determining the Density of Smoke. Describes the system invented by Ringelmann, of Paris, used in Europe in connection with tests of steam boilers and of smoke-preventing appliances, with cards required for using the system. 600 w. Eng News—Nov. 11, 1897. No. 16568.

Standard Trials.

Draft of the Report of the Committee on the

Revision of the Society Code of 1885, Relative to a Standard Method of Conducting Steam-Boiler Trials. 16000 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16835 D.

Tests.

Boiler Tests: Classification of Data and Plotted Results William Wallace Christie. A large collection of tests have been tabulated and the results plotted in diagrams. Tables. Trans Am Soc of Mech Engs—Dec., 1897. No. 16831 D.

Some Boiler Tests at Drummond Colliery. Charles Fergie. The boilers tested were two Stirlings and one Heine, having been in use three and five years, respectively. 1200 w. Can Min Rev—Oct., 1897. No. 16315 B.

Water Tube Boilers.

See Marine Engineering.

COMPRESSED AIR.

Air.

Air Talk. Irving A. Taylor. Discusses the De Bausset air ship and also liquefied air, showing that the first is not practical, and the second very costly. 1500 w. Elec Eng, N. Y.—Oct. 28, 1897. No. 16232.

Air Motors.

Experience with Hoadley-Knight Air-Motor Cars in Washington, D. C. Reports, giving particulars of tests made in the Eckington & Soldiers' Home Railway, generally favorable to the system. 2800 w. Eng News—Nov. 4, 1897. No. 16365.

Compressor.

Corliss-Valved Air Compressor. Describes a compressor patented by Ferdinand Strnad, which compresses the air in one operation to five atmospheres above the atmosphere, with only one air cylinder. From a communication by Herr Kaufhold, of Düsseldorf, to *Glückauf*. Ill. 2700 w. Prac Eng—Oct. 22, 1897. No. 16258 A.

Efficiency of a Four-Stage Air Compressor Delivering Air to a Storage Reservoir. The paper is supplementary to records published in the issue of Oct. 7, giving the total efficiency of the Ingersoll-Sergeant apparatus, and the results derived from it. 1600 w. Eng News—Nov. 4, 1897. No. 16367.

Delaware Breakwater.

The Use of Compressed Air in Building the Delaware Breakwater. C. Weber. Illustrated description. 1400 w. Compressed Air—Nov., 1897. No. 16874.

Explosions.

Explosions of Air Compressors. (Explosionen an Luftkompressoren.) F. Strnad. With details of explosions in various parts of Europe, and a discussion of the causes and remedies. In every case an explosive mixture of air and vapor of oil was ignited by the heat due to the pressure. 3500 w. Glückauf—Oct. 9, 1897. No. 16480 B.

Jerome Park, N. Y.

Abstract of Thesis Test of Compressed-Air Power Plant at Jerome Park, N. Y. George W. Vreeland and Charles M. Younglove. The purpose of the test was to determine the various efficiencies of a central power plant and point out any line of improvement that may be necessary. 1500 w. Compressed Air—Nov., 1897. No. 16873.

Propulsion.

Notes on Propulsion by Compressed Air. (Mittheilungen über Pressluftbetrieb.) A paper, chiefly historical, read before the German Society of Railway Engineers by Herr Henning. Comparisons of cost between propulsion by compressed air and by electricity are given. 4500 w. Glaser's Annalen—Oct. 15, 1897. No. 16438 D.

ENGINES AND MOTORS.

Air Motors.

See Compressed Air.

Alcohol Motors.

Investigations upon Alcohol Motors. (Recherches sur les Moteurs à Alcool.) Max Ringelmann. Showing that more than double the quantity of alcohol is required than of petroleum, for the same power developed, and that with the present prices of alcohol and petroleum the former is commercially impracticable. 1500 w. Comptes Rendus—Oct. 18, 1897. No. 16434 B.

Blowing Engine.

An Improved Blowing Engine. (Eine Neuerung im Gebläsebau.) Illustrated description of the improved blast furnace compound blowing engine with "ring" valves for the air cylinder, as built for the Vajdahunyad Steel and Iron Works in Hungary. Details of working parts are given. 6000 w. Stahl und Eisen—Nov. 15, 1897. No. 16477 D.

Compound Beam Blowing Engine at the Pribram Silver and Lead Works. (Die Balancier-Compound Gebläsemachine bei der Silver- und Bleihütte in Pribram) A description of the new blowing engine at Pribram, Bohemia, with plate of drawings, indicator diagrams and account of test. 1 plate. 7000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 5, 1897. No. 16412 B.

Breakdowns.

Engine Breakdowns. Extracts from the annual report of the chief engineer of the Engine, Boiler, and Employers' Liability Insurance Co., Limited. Mr. Michael Longridge; with editorial. Ill. 3300 w. Prac Eng—Oct. 22, 1897. No. 16257 A.

Condenser.

The Balcke Tower Condenser. (Kaminkühler Anlage, System Balcke.) Illustrated description of a surface condenser for 2000 h. p. on the Balcke system, with cooling tower for repeated use of condensing water, as shown at the Leipzig exposition. 2000 w. 1 plate. Glaser's Annalen—Oct. 15, 1897. No. 16441 D.

Economizers.

Economizers. Henry G. Brinckerhoff. Discusses their proper construction and uses. Paper read at the meeting of the New England Cotton Manufacturers' Assn., at Philadelphia. 1200 w. Bos Jour of Com—Oct. 30, 1897. No. 16242.

Economy.

Clearance and Compression. F. F. Hemenway. The influence which they extend upon the economy of a steam engine is explained. 2000 w. Mach, N. Y.—Nov., 1897. No. 16527.

Efficiencies.

Multiple-Cylinder Steam Engines. Effects of Variation of Proportions and Variable Loads. Robert H. Thurston and Louis L. Brinsmade. Results of experimental investigation of the relative efficiencies of different engines, under stated conditions. 9000 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16830 D.

Engine Efficiency.

See Marine Engineering.

Engine Test.

An Efficient Steam Plant. An interesting test madè by George H. Barrus, at the Grosvenordale Mills, in Connecticut, to determine whether the engine fulfilled the guarantee of its builders, and including a test of the boilers and economizers. 2500 w. Eng Rec—Nov. 20, 1897. No. 16728.

Exhibition.

Boilers and Motors at the Saxon-Thuringian Exhibition at Leipzig, 1897. (Dampfkesseln und Motoren auf der Sächsisch-Thuringischen Gewerbeausstellung zu Leipzig, 1897.) With plans of engine and boiler house, and description of general arrangement, including condensers, feed pumps, and coal-handling plant. 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 2, 1897. Serial. 1st part. No. 16401 D.

Gas Engine.

A New Two-Cycle Gas and Kerosene Engine. Illustrated description of two recent designs, known as Mietz and Weiss gas and oil engines, which bid fair to rival the four-cycle type. 1300 w. Eng News—Nov. 25, 1897. No. 16839.

Gasoline Motor.

The Patton Gasoline-Electric Motor for Street Railways. Describes a self-contained motor car, driven by electricity which is generated by a gasoline engine and electric dynamo on the car. 600 w. Eng News—Nov. 11, 1897. No. 16571.

Governors.

The Thunderbolt Governor. Illustrated description of a most ingenious system of governing. 1100 w. Elec Rev, Lond—Oct. 29, 1897. No. 16381 A.

High-Speed.

High-Speed Self-Lubricating Steam Engines. Alfred Morcom. Read before the Institution of Mechanical Engineers (England). An account of the part taken in their development by the firm of Messrs. G. E. Belliss and Co. and a comparison of their engines with other makes. 5500 w. Jour Am Soc of Nav Engs—Nov., 1897. No. 16599 H.

History.

The Steam Engine. J. S. Raworth. A summary of the last twenty-five years. 2800 w. Elec Rev, Lond—Nov. 12, 1897. No. 16748 A.

Inertia.

Analysis of the Inertia Forces of the Moving Parts of an Engine. John H. MacAlpine. The object of this investigation was to deduce, by harmonic analysis, simple and useful expressions for some of the periodic functions connected with the ordinary connecting-rod engine. They are published now because of their importance in explaining the occurrence in steamships of vibrations of shorter period than that of the revolution of the engine. 3500 w. Engng—Oct. 22, 1897. Serial. 1st part. No. 16278 A.

Motors.

See Electrical Engineering, Power.

Pumping Engine.

See Municipal Engineering, Water Supply.

Rotary Engine.

The Almond Engine. Illustrates and describes a novelty in a rotary engine, which, it claims, is free from all the standard objections to engines of this type. 700 w. Am Mach—Nov. 4, 1897. No. 16347.

Turbines.

The De Laval High-Pressure Steam Turbines at the Stockholm Exhibition. Illustrated description of the high-pressure steam turbine and boiler plant which furnished electric light for the entire exhibition. 1000 w. Elec Eng, N. Y.—Nov. 11, 1897. No. 16540.

Valve Gear.

See Marine Engineering.

POWER AND TRANSMISSION.

Cost.

The Comparative Cost of Steam and Electric Power. Irving A. Taylor. Discussion of how to supply and distribute power with the best economy and convenience. 2000 w. Elec Eng, N. Y.—Nov. 25, 1897. Serial. 1st part. No. 16852.

The Cost of the Generation of Power. (Kosten der Krafterzeugung.) Chr. Eberle. A very full investigation into the relative cost of steam and gas motors as sources of power. Computations are given for units from 200 to 1000 h. p. A valuable paper. 8000 w. Zeitschr f Elektrochemie—Oct. 5, 1897. No. 16453 B.

Elevators.

A Fireproof Grain Elevator. Description of an interesting structure in Buffalo, N. Y. Ill. 1800 w. Eng Rec—Nov. 27, 1897. No. 16879.

Electric or Hydraulic Elevators in Toronto? Abstract of report of E. H. Keating regarding the relative merits of the two systems in order to determine which shall be installed in the new municipal building. The only point where a difference can be considered is in repairs and maintenance and running expenses, and these cannot be determined from facts known. 3000 w. Eng Rec—Nov. 27, 1897. No. 16880.

Modern High-Speed Elevators. Charles E. Emery. Abstract from lecture delivered before students of Sibley College. Reviews the various appliances for lifting, and explains the principles of the modern high-speed elevator. 3000 w. Sib Jour of Engng—Nov., 1897. No. 16866 C.

See also Electrical Engineering, Power.

Fly-Wheels.

Fly-Wheel Accident at Providence, R. I. An account of the accident, on Sept. 22, at the factory of the Providence Rubber-Shoe Company. Ill. 1800 w. Power—Nov., 1897. No. 16288.

Gas Power.

A Modern Gas Power-Plant. Horace Allen. The gas generator described is of 300 h. p. capacity, and works on the Thwaite patent continuous cycle. Report of tests is given. 1300 w. Engr, Lond—Oct. 29, 1897. No. 16512 A.

Gears.

A Strength of Gear Chart. John B. Mayo. Chart with explanation. 1500 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16832 D.

Gearing.

Unit System of Gearing at the Tennessee Exposition. S. Groves. Describes the special form of gearing employed in the operating mechanism of the see-saw, designed by A. J. Dyer. Ill. 1500 w. Ir Trd Rev—Oct. 28, 1897. No. 16235.

Haulage.

Heckel's Arrangement of Endless-Rope Haulage. M. J. Kersten. From a communication to the Brussels section of the Assn. des Ingénieurs de Liège. Illustrated description of method by which it is claimed that a saving of 10 centimes per ton-kilometre may be effected. 1800 w. Col Guard—Nov. 5, 1897. No. 16650 A.

Mechanical Haulage by Endless Cable. J. Kerston. Communicated to the Assn. des Ingénieurs Sortis de l'Ecole de Liège, and translated from *Revue Universelle des Mines, de la Métallurgie, etc.* Describes a system of mechanical haulage equally suitable for surface requirements or underground purposes. Ill. 1700 w. Ind & Ir—Oct. 22, 1897. No. 16256 A.

The Development of Electric Cableways. Richard Lamb. Describes its application to logging in swamps, canal practice, quarry purposes, &c. Ill. 2500 w. Elec Eng, N. Y.—Nov. 4, 1897. No. 16330.

Power Transmission.

See Marine Engineering.

Printing Machinery.

See Electrical Engineering, Power.

Rope Driving.

A Problem in Continuous Rope Driving. Spencer Miller. Calls attention to the perplexing problems which occur in driving with ropes, showing that with the continuous-rope plan of driving a large increase of power transmitted is obtained. Ill. 4000 w. Pro Am Soc of Civ Engs—Nov., 1897. No. 16862 F.

Steam Power.

Reduction in Cost of Steam Power from 1870 to 1897. F. W. Dean. Presents the economies of this period and the actual cost. 4000 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16824 D.

Transmission.

See Electrical Engineering, Power.

Wave Motor.

The Fletcher Wave Motor. An account of the experimental test recently made at Dover, England, describing the plant and the results of test. Ill. 1600 w. Elec Eng, N. Y.—Nov. 25, 1897. No. 16851.

The Utilization of Wave-Power. Describes the working of the wave motors invented by B. Morley Fletcher. Ill. 2500 w. Ind & Ir—Oct. 29 1897. No. 16383 A.

SHOP AND FOUNDRY.

Bearings.

Roller Bearings and Their Applications. Thomas W. How. Read before the Manchester Assn. of Engineers. Discusses the advantages, the requirements and details of construction, and results already obtained. Ill. 2000 w. Prac Eng—Nov. 5, 1897. Serial. 1st part. No. 16666 A.

Bicycle Factory.

A Trip Through a Large Bicycle Factory. Illustrates the design and manufacture of bicycles as carried out at the factory of the Eclipse Bicycle Company, of Elmira, N. Y. 2000 w. Sci Am—Nov. 6, 1897. No. 16353.

Casting.

The Casting of Art Bronze. From *La Nature.* Describes processes and gives interesting information. Ill. 1000 w. Sci Am—Nov. 6, 1897. No. 16354.

The Use of the Riser in Casting. Showing the action of risers for feeding, for relieving the mold of dirty metal, and for indicating the filling of the mold. 1800 w. Mech Wld—Nov. 5, 1897. No. 16647 A.

Cost-Keeping.

Cost-Keeping Methods in Machine Shop and Foundry. Henry Roland. Particularly reviewing methods of checking piece production in order to prevent waste or theft. Details of methods of leading shops are given and examples of the revelations of the application of proper checking methods. 4000 w. Engineering Magazine—Dec., 1897. No. 16898 B.

Cylinder-Heads.

Experiments on the Strains and Stresses on Flat Cylinder-Heads (Untersuchungen über die Formänderungen und die Anstrengung Flacher Boden.) C. Bach. A very thorough series of tests, the deformations being carefully measured for various pressures. Both cast and wrought iron heads, 28 in. diameter, were tested. 3 articles, 2 plates. 20000 w. Zeitscher d ver Deutscher Ing—Oct. 9, 16, 23, 1897. No. 16402 H.

Cylinders.

Method of Boring Large Cylinders in a 72-inch Lathe. Alfred Dunn. A brief illustrated description of the methods used for boring and facing a 64"x10' 6" cylinder at one setting. 400 w. Mach, N. Y.—Nov., 1897. No. 16529.

Emery Wheels.

The Emery Wheel and Its Manufacture. Illustrated description of the plant of the Sterling Emery-Wheel Mfg. Company of Tiffin, Ohio, with interesting information about this abrasive. 1300 w. Ir Age—Nov. 4, 1897. No. 16326

Grading.

The Grading of Cast Iron by its Composition. (Die Bewerthung des Roheisens auf Grund seines Verhaltens beim Gattiren mit Brucheisen.) Dr. Wüst. An important paper, showing that irons may be graded satisfactorily by their chemical composition and that test results may be repeated by proper selection of pig and proportion of scrap; with large table of actual examples. 5000 w. Stahl und Eisen—Oct. 15, 1897. No. 16473 D.

Iron Melting.

The Melting of Iron in the Reverberatory Furnace and the Cupola. E. H. Putnam. A discussion of reverberatory-furnace construction, the quality of iron to be used, chilled castings, cupola management for chilled work, &c. 3000 w. Ir Trd Rev—Oct. 28, 1897. No. 16236.

Metal Working.

Experimental Study of Shearing and Punching Metals. (Etude Expérimentale du Cisaillement el du Poinçonnage des Métaux.) M. Frémont. A very full discussion of the work required in punching and shearing, with diagrams, photographs and sections. An important and valuable paper. 30000 w. Bulletin de la Société d'Encour—September, 1897. No. 16437 G.

Mixtures.

Concerning Mixtures of Cast Iron and Steel. (Du Mélange de la Fonte el de l'Acier.) M. J. Vinsonneau. Giving the results of tests of cast iron to which steel has been added during the melting. A marked increase in strength is obtained. Not more than 15 per cent. of steel should be added. 2000 w. Moniteur Industriel—Oct. 23, 1897. No. 16495 F.

Molding.

Machine Molding Without Stripping Plates. E. H. Mumford. Describes machine and its operation. 1600 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16816 D.

Plaster Casts and Other Methods of Molding Shell Forms. John C. Knoeppel. Read at Chicago meeting of the Western Foundrymen's Assn. Describes the making of the casts and their use, the taking of block patterns by stripping, &c. 2300 w. Ir Age—Nov. 25, 1897. No. 16860.

Views on Molding Sand. Interesting discussion by Western Foundrymen at the meeting in Cincinnati, of the paper read by D. H. Truesdale. 5000 w. Ir Trd Rev—Nov. 4, 1897. No. 16360.

Pig Iron.

The Valuation of Pig Iron in Foundry Practice. Dr. Wüst. Read at the meeting of the German Foundrymen's Assn. at Goslar, Prussia. Condensed translation. Showing that the value depends on the chemical composition. 2500 w. Am Mfr & Ir Wld—Nov. 12, 1897. No. 16624.

Railroad Shops.

See Railroad Affairs, Terminals & Yards.

Screw Die.

A Screw Die for the Turret Lathe. James Hartness. Description of a screw-cutting die, possessing novel features, and mention of other means now employed for the same purpose. Ill. 1300 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16823 D.

Shafts.

Relative Proportions of Solid Shafts, Hubs, Sleeves, and Hollow Shafts. Henry Hess. Gives diagram of solid- and hollow-shaft, hub and sleeve relations, with directions for use 2000 w. Am Mach—Nov. 18, 1897. No. 16681.

Shop Arrangement.

A Model Saxon Shop. Illustrated description of the shops of J. E. Reinecker, Goblenz-Chemnitz (Saxony). 1200 w. Mach, N. Y.—Nov., 1897. No. 16528.

A Modern Machine Shop. (Eine Moderne Maschinenbauwerkstätte.) Prof. Theobald Demuth. An illustrated account of the new shop of Kolben & Co. at Prag-Visocan. Nearly all the machine tools are driven by independent motors; electric cranes are used, and all the arrangements are of the most recent types. 3500 w. Zeitschr d ver Deutscher Ing—Oct. 23, 1897. No. 16404 D.

An English Engineering Shop and Some of Its Products. F. J. M. Describes the shop of Joshua Buckton & Co. of Leeds, and the work done there, giving illustrations of machines. 2700 w. Am Mach—Nov. 4, 1897. No. 16344.

Shop Organization.

How Can Shop Organization Be Made More Effective? L. L. Smith. Describes the present organization of a locomotive shop, and discusses economies. Abstract of paper read before the Western Railway Club. 2000 w. Am Eng & R R Jour—Nov., 1897. No. 16241 C.

Sprocket Wheels.

Sprocket-Wheel Finishing Machine. Illustrated description of a machine designed for boring, tapping, facing, and forming sprocket wheels for bicycles, but adapted to other work of like nature. 600 w. Am Mach—Nov. 4, 1897. No. 16346.

Standards.

Standard Fits in the Machine Shop. Arthur A. Fuller. Explains the peculiar adaptation of the limit system in this field, and reports cases of its application. Ill. 2700 w. Mach, N. Y., —Nov., 1897. No. 16526.

Stay Bolts.

A Stay-Bolt-Threading Device. James Hartness. Describes a means for threading stay bolts. Ill. 400 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16818 D.

Test Bars.

Test Bars in the Foundry. R. Moldenke. Read at meeting of the Pittsburgh Foundrymen's Assn. Urging the adoption of standard methods for testing the work. 1400 w. Ir Age—Nov. 25, 1897. No. 16861.

Tools.

Riveting Tools. A. H. Cleaves. Describes tools used and plan of work in riveting a number of thin brass pieces. Ill. 700 w. Am Mach—Nov. 4, 1897. No. 16345.

Special Tools in the Missouri Pacific Shops. Illustrated description of molds for piston-rod packing, chuck for screwing in stay bolts, equalizer clamp, pneumatic dolly bar, and flue expander. 800 w. R R Gaz—Nov. 5, 1897. No. 16370.

Turning.

Device for Turning Slender Metal Articles. Illustrated description of a machine invented by J. D. Mattison. 700 w. Am Mach—Nov. 18, 1897. No. 16680.

Venting.

The Venting Tool. Thomas F. Kennedy. Condemns the usual practice in foundries and the means used for venting; describes how to make a small vent wire, discussing handles and large vent wires. 2500 w. Metal Work—Nov. 6, 1897. No. 16336.

Wrought Castings.

Mitis Founding. K. K. Gives a general idea of the process of making castings from wrought iron. Ill. 2000 w. Am Mach—Nov. 25, 1897. No. 16838.

MISCELLANY.

Automobile.

Road Motors in France. An account of the efforts of the Automobile Club of France to initiate a new class of heavy-weight vehicles, for carrying passengers and baggage. Ill. 1600 w. Engng—Nov. 5, 1897. No. 16618 A.

Bicycles.

Machinery and Tools for Bicycle Construction. (Maschinen und Geräte zur Herstellung von Fahrrädern.) With numerous illustrations of special devices for bicycle manufacturing and assembling, mostly from American sources. Serial. 1st part. 4500 w. Zeitschr d Ver Deutscher Ing—Oct. 2, 1897. No. 16400 D.

Patents and the Bicycle. E. Ralph Estep. On the worthlessness of many patented appliances. 1600 w. Ir Age—Nov. 18, 1897. No. 16682.

Some Points in Cycle Construction. F. J. Osmond. From a paper read before the Institution of Mechanical Engineers, England. Considers friction and rigidity in their relation to the efficiency, and discusses points affecting these. 3300 w. Am Mach—Nov. 18, 1897. No. 16679.

Bicycle-Tires.

Some Types of English Bicycle-Tires. Brief illustrated description of various makes. 1500 w. Ind Rub Wld—Nov. 10, 1897. No. 16671 D.

Computing.

The Comptometer. Fred Morley. Describes and explains the method of operating a practical calculating machine. Ill. 2000 w. Pro of Purdue Soc of Civ Engs—1897. No. 16808 D.

Corrosion.

Internal Corrosion of Wire Ropes. T. G. Lees. Extract from paper read at joint meeting of engineers at Sheffield, Eng., with short discussion. Favors galvanized wire ropes. 2000 w. Col Guard—Oct. 29, 1897. No. 16505 A.

Grain Handling.

Handling the Grain Crop at the Port of New York. Interesting description of the facilities for transporting and handling the immense grain crops of the western states. Ill. 2800 w. Sci Am—Nov. 20, 1897. No. 16690.

Mechanical Composing.

The Lanston "Monotype" Composing and Type-Casting Machine. Illustrated detailed description. 2600 w. Ind & Ir—Nov. 12, 1897. No. 16778 A.

Mechanical Designs.

Idiosyncrasy in Mechanical Engineering. Editorial discussion calling attention to the fact that peculiarities of design are due to individual or national idiosyncrasies. 2200 w. Engr, Lond—Nov. 5, 1897. No. 16646 A.

Paper.

Old Paper. (Alte Papier.) W. Herzberg. An account of investigations made by the chief of the paper testing department of the Charlottenburg laboratory, showing that paper of former times was inferior to that now made. 8000 w. Mitt a d Kgl Tech Versuchsanstalt—Part II, 1897. No. 16447 F.

Refrigerating.

Ammonia Refrigerating Machine. Illustrated description of the invention of B. Lebrun, of Nimy, Belgium, its special feature being the use of two compression cylinders, each opening into a framing filled with oil, so arranged that, if there is leakage, it will be oil and not ammonia. 900 w. Engng—Oct. 22, 1897. No. 16274 A.

Resistance Computations.

Prismatic Moments Considered as Surface Moments of the Second Order in Computations of Resistance. (Die Säulenmomente als Darstellung der Flächenmomente Zweiter Ordnuug in der Festigkeitslehre.) Prof. R. Land. A mathematical discussion simplifying computations involving the moment of inertia in mechanical and statical problems. 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 30, 1897. No. 16405 D.

Strains.

The Computation of Strains in Coal and Grain Bins. A number of letters presenting many diverging views, called out by an article printed in this paper, Sept. 23, 1897, with comments. 4800 w. Eng News—Nov. 4, 1897. No. 16366.

Telescope.

The 40-inch Telescope of the Yerkes Observatory. William E. Reed. Illustrated detailed description, with interesting information. 6500 w. Jour Assn of Engng Socs—Oct., 1897. No. 16791 C.

Testing.

New Method of Testing Metals. (Nouvelle Méthode d'Essai des Métaux.) M. Fremont.

An improved bending test, the ends of the specimen being supported on roller bearings. The data are obtained by measuring the deformations of lines upon the surface of the test piece. 1500 w. Comptes Rendus—Oct. 4, 1897. No. 16436 B.

The Influence of Method of Testing Upon the Results of Bending Tests at Low Temperatures. (Einfluss des Prüfungsverfahrens auf das Ergebriss der Biegeproben bei Niederen Wärmegraden.) Prof. Rudeloff. A graphical and analytical discussion of the results which are secured by the employment of various methods of testing at low temperatures, on various grades of steel. 16000 w. 1 plate. Mitt a d Kgl Tech Versuchsanstalt—Part II., 1897. No. 16446 F.

Testing Machine.

A Photographic Impact Testing Machine for Measuring the Varying Intensity of an Impulsive Force. B. W. Dunn. Describes investigations made, tracing the development of the time and distance-measuring parts of the apparatus and showing their combination for simultaneous use. 6500 w. Jour Fr Inst—Nov., 1897. No. 16323 D.

Valuation.

The Valuation of Textile-Manufacturing Property. Charles T. Main. A discussion of the methods of determining value. 13000 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16817 D.

Wire.

A Convenient Form of Wire-Testing Machine. Arthur L. Rice. Illustrated description. 300 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16822 D.

Wire. A. L. Orton, in *Sibley Journal of Engineering.* Gives history of the development and much general information. 2000 w. Age of St—Nov. 20, 1897. No. 16765.

Wire Rope.

Influence of Materials and Construction upon the Strength of Wire Rope. (Einfluss des Materials und der Konstruktion auf die Festigkeit von Drahtlitzen.) Prof. Rudeloff. A most exhaustive report upon the tests made at the Charlottenburg laboratory. A very valuable contribution to engineering knowledge. 30000 w. Mitt a d Kgl Tech Versuchsanstalt—Parts III and IV, 1897. No. 16448 H.

MINING AND METALLURGY.

COAL AND COKE.

British India.

The Production of Coal in British India in 1896. Shows the encouraging prospects for this growing industry. 1300 w. Ind & East Engr—Oct., 1897. No. 16688 D.

Brown Coal.

The Grottau Brown Coal Deposit, North Bohemia. Fried. Katzer, in *Oesterreichische Zeitschrift für Berg- und Hüttenwesen.* Describes the deposit and working. 900 w. Col Guard—Nov. 5, 1897. No. 16652 A.

The Lignite Beds at Grottau in Northern Bohemia. (Die Grottauer Braunkohlenablagerung in Nordböhmen.) Describing these important deposits of soft brown-coal, with map and geological sections. Two articles, 1 plate. 5000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 9, 16, 1897. No. 16484 E.

Coal Testing.

Apparatus for Testing Coal Samples. M. A. Dory. From a communication to the Société des Ingénieurs des Mines du Hainaut. Illustrated description of apparatus and its operation. 1300 w. Col Guard—Nov. 12, 1897. No. 16782 A.

Coke Oven.

The Improved Simon Carves Coke Oven. Illustrated description of this well-known oven in its improved form. 900 w. Eng & Min Jour—Nov. 13, 1897. No. 16616.

Coke Plant.

A Model Coke Plant. Illustrated description of coke plant No. 2, of the Oliver Coke and Furnace Company, near Uniontown, Pa. 700 w. Mines & Min—Nov., 1897. No. 16627 C.

The Otto-Hoffmann Coke-Oven Plant at Glassport, Pa. Illustrated description. 1800 w. Ir Age—Nov. 11, 1897. No. 16534.

Coking.

Half a Century of Coke and Coking Processes. Part first gives statistics of recent progress, and the economy possible from the utilization of by-products and waste gases. 2500 w. Ir & Coal Trds Rev—Nov. 12, 1897. Serial. 1st part. No. 16785 A.

Laborers.

Anthracite Mine Laborers. G. O. Virtue. Shows that their lot in the Pennsylvania region has never been an easy one, and that at present it is even harder than ever. 22000 w. Bul Dept of Labor—Nov., 1897. No. 16805 D.

South Africa.

The Middelburg Coalfields (South Africa). Herbert Lloyd. Describes the region, formations, quality, etc.; also other minerals to be found in this district. 1100 w. Col Guard—Nov. 12, 1897. No. 16781 A.

COPPER.

Michigan.

Brief Description of the Calumet and Hecla Mine, Lake Superior, Michigan. E. McCormick. A diagram, showing method of procedure, and details of work are given. 1000 w. Min & Sci Pr—Nov. 13, 1897. No. 16699.

GOLD AND SILVER.

Australia.

Benalla Goldfield (Vic.) W. H. Ferguson. Report, with plan, of this field, describing the reefs, alluvial claims, and prospecting. 2000 w. Aust Min Stand—Oct. 21, 1897. No. 16793 B.

First Impressions of Westralia. T. A. Rickard. Brief description of Western Australia. 1200 w. Eng & Min Jour—Nov. 20, 1897. No. 16724.

Resources of the Northern Territory. W. G. Stretton. From the *Northern Territory Times*. Reports the minerals found and the mines worked. Gold is the most important mineral. 2300 w. Aust Min Stand—Oct. 21, 1897. No. 16794 B.

Crucibles.

Notes on Assaying Ground-Graphite Crucibles. Andrew F. Crosse. Describes a method found to give satisfactory results in making assays on this class of material. Short paper with discussion, including interesting notes by the president, Charles Butters, on the gold that is found in the by-products. 5700 w. Chem & Met Soc of S Africa—Sept. 18, 1897. No. 16322 D.

Cyanid Process.

Charcoal in Cyaniding. Norman Danvers Power. Gives information relating to the use of this precipitant, and directions for the process. 1500 w. Aust Min Stand—Oct. 14, 1897. No. 16769 B.

Cyaniding Sulphide Gold Ores. R. Recknagel. Remarks on this subject, causes of failures, differences in extraction, &c. 3300 w. Eng & Min Jour—Nov. 13. 1897. No. 16617.

Gold, Zinc, and Electrolysis. (Gold, Zink, und Elektrolyse.) A paper by E. Andreoli discussing the Siemens method of reducing gold from a cyanid solution by electrical deposition, instead of zinc shavings. 3500 w. Elektrochemische Zeitschr—Oct., 1897. No. 16460 B.

Dredging.

Gold Dredging in Montana. Eugene B. Braden. Illustrated description of dredging experiments in this state, with their results. 2500 w. Eng & Min Jour—Nov. 20, 1897. No. 16722.

Notes on Dredging for Gold. John W. Gray. Information of dredges used and the success of the work both in America and New Zealand. 2300 w. Min & Sci Pr—Nov. 13. 1897. No. 16698.

Gold Ore.

The Estimation of Gold in Ore, and Data on Dry-Crushing Experiments. Franklin White. Read before the Chemical and Metallurgical Society of South Africa. Tables showing the possibility of assaying ore before crushing with sufficient accuracy to afford very useful information. One set of calculations refers to wet milling, one to a dry-crushing test. 1700 w. Chem & Met Soc of S Africa—Oct. 16, 1897. No. 16763 D.

Gold Seeking.

Gold Dredging and Gold Saving. Perry F. Nursey. Describes the invention of Charles Ball for automatically securing the gold. Also reviews the systems of dredging which have been used from the earliest time to the present. 1800 w. Ind & Ir—Oct. 29, 1897. No. 16382 A.

Klondike.

How Gold is Mined on the Klondike and the Chances of Fortune There. A statement of facts showing that the region is not nearly as rich as was California in 1850. 1500 w. Eng & Min Jour—Nov. 27, 1897. No. 16869.

Railways to the Klondike. An account of the various projects for furnishing improved transportation to the Alaskan gold fields. Map. 1200 w. Ry Age—Oct. 29, 1897. No. 16361.

Route to the Yukon. A description of the overland route via Juneau, over the White and Chilkoot passes, and down the Yukon, as given in the Juneau *Mining Record*. 2200 w. W Min Wld—Nov. 6, 1897. No. 16546.

The Klondike Placers. T. K. Rose. Brief history of the district, with description of the gold fields, and methods of working. 1700 w. Nature—Oct. 28, 1897. No. 16384 A.

Ladue Company.

The Joseph Ladue Company's Directors Incredible Credulity. Editorial criticism of the prospectus of this company. 2700 w. Eng & Min Jour—Nov. 27, 1897. No. 16870.

Mother Lode.

A Few Miles of the Mother Lode in California. R. W. Petre. The almost uniform results of deep mining on a few miles of the Mother Lode has caused it to be regarded by many as infallible. 2000 w. Eng & Min Jour —Nov. 27, 1897. No. 16872.

New Zealand.

Gold Mining at Preservation Inlet. Richard Allen. Information of this locality and how it was discovered, and of the mines located and worked. 2000 w. New Zealand Mines Rec—Oct. 16, 1897. No. 16804 B.

Nuggets.

World's Big Nuggets. Interesting account of the finding of nuggets in curious places, and under peculiar circumstances. 1500 w. W Min Wld—Nov. 20, 1897. No. 16795.

Placer Mining.

The American Hill Placer Mine, Idaho. Edmund Juessen. Illustration, with description of methods of working. 800 w. Eng & Min Jour—Nov. 27, 1897. No. 16871.

Refining.

Metal-Refining Methods. (Metallhüttenwesen.) C. Schnabel. A discussion of the latest refining methods for gold and silver including the cyanid treatment of gold ores in various parts of the world, and the Stetefeldt and Dewey-Walther silver processes. Two articles. 9000 w. Zeitschr de Ver Deutschr Ing—Oct. 9, 23, 1897. No 16403 G.

Slimes.

The Treatment of Battery Slimes. Discussion on J. R. Williams' paper by the society members. 2800 w. Chem & Met Soc of S Africa—Sept. 18, 1897. No. 16321 D.

Smelting.

British Columbia Smelting Development. Reviews the present conditions and the opportunities for development, giving report of numerous projects of great importance. 1800 w. Can Min Rev—Oct., 1897. No. 16313 B.

Witwatersrand.

The Economic Value of the Main Reef (Witwatersrand). Fischer Wilkinson. Read before the society. Statistically investigating the value of the Main Reef series, how much is paying now and the future prospects. 2700 w. Chem &. Met Soc of S Africa—Oct. 16, 1897. No. 16764 D.

The Gold Mines of the Witwatersrand (Mines d'Or du Witwatersrand.) A review of the relation of the variations of the prices of mining shares to the cost of development, based upon data obtained by M. Perrier de la Bathie, from the mines of the Transvaal. 4500 w. Le Génie Civil—Oct. 23, 1897. No. 16423 D.

IRON AND STEEL.

Address.

Presidential Address of F. W. Paul at the Glasgow Meeting of the West of Scotland Iron and Steel Institute. Deals with blast-furnaces and by-products, open-hearth steel, melting furnaces, Bertrand-Thiel process, Stockman process, &c. 6500 w. Ir & Coal Trds Rev—Oct. 29, 1897. Serial. 1st part. No. 16507 A.

American Steel.

American Steel Supreme. D. Allen Willey. Showing that the price of fuel and supply of ore enable America to supply the world, if transportation rates can be obtained on an equitable basis. 1700 w. Mfrs Rec—Nov. 26, 1897. No. 16836.

Axles.

Steel and Iron Axles. R. A. Mould. Read before the National Railway Master Blacksmiths' Assn. Information respecting the wearing qualities of iron and steel axles, showing the superiority of the latter. 1600 w. Ir & St Trds Jour—Oct. 30, 1897. No. 16356 A.

Belgium.

Coal and Iron in Belgium (Kohle und Eisen in Belgien.) A statistical and comparative view of the Belgian coal and iron industry from 1870 to 1895. 6000 w. Stahl und Eisen—Nov. 15, 1897. No. 16479 D.

British Steel.

The British Steel Industry. The returns for the first six months of the current year show the largest output ever produced in the same time in any European country. 1000 w. Arch, Lond—Oct. 22, 1897. No. 16287 A.

Edison Works.

Magnetic Ore Separation at Edison, New Jersey, U. S. A. This interesting plant is illustrated and described, and information relating to its working is given. 3200 w. Engng—Nov. 12, 1897. No. 16736 A.

The Edison Iron-Ore Concentrating Works at the Ogden Mines, Edison, N. J. Particulars of the works, methods and machinery. 1800 w. Eng News—Nov. 11, 1897. No. 16567.

Electrolysis.

See Electrical Engineering, Electrochemistry.

Impact.

Cast Iron under Impact. W. J. Keep. Describes experiments made to determine the influence of shock on cast iron, showing incidentally the use of mechanical analyses in determining the cause of physical changes which take place in cast iron. 8400 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16819 D.

Iron Industry.

The Iron Industry of Great Britain Sixty Years Ago. Interesting information from a report of a journey through the iron-manufacturing districts. 3200 w. Ir & Coal Trds Rev—Nov. 5, 1897. No. 16660 A.

Iron Melting.

See Mechanical Engineering, Shop & Foundry.

Magnetism.

The Ferromagnetic Properties of Iron and Steel. J. A. Fleming. A lecture delivered to the Sheffield Society of Engineers and Metallurgists. A review of the chief facts concerning ferromagnetism, with explanations. 3800 w. Elect'n, Lond—Oct. 22, 1897. Serial. 1st part. No. 16283 A.

Magnetite.

On the Magnetite Belt at Cranberry, North Carolina, and Notes on the Genesis of this Iron Ore in General in Crystalline Schists. James P. Kimball. Describes topography, formation and developments; gives analyses and interesting particulars. 4300 w. Am Geol—Nov., 1897. No. 16320 D.

Phosphorus.

The Rapid Determination of Phosphorus. (Schnelle Phosphorbestimmung.) A brief account of an improved method of determining the percentage of phosphorus in iron by the magnesia process, as used by M. Wdowiszewski, chemist of the Kulebaki iron works. Four hours time is sufficient, instead of 1 to 3 days, as formerly. 1500 w. Stahl und Eisen—Oct. 1, 1897. No. 16471 D.

Reducibility.

Methods of Determining the Reducibility of Iron Ores. (Verfahren zur Bestimmung der Reducirbarkeit der Eisenerze.) Prof. J. Wiborg. A paper read before the International Association for Testing Materials, at Stockholm, 1897, Description of various methods, and table of results for different ores. Two articles. 7500 w. Stahl und Eisen—Oct. 1, 15, 1897. No. 16470 G.

Steel Making.

The Tropenas Process of Steel Making. A letter from the Imperial Steel Works, of Sheffield, Eng., testifying to the success of the process, with summary of claims made by the inventor in his specification, and comments of Dr. Henry M. Howe. 2700 w. Eng News—Nov. 4, 1897. No. 16368.

Wrought Iron.

Hints About Iron. B. F. Spalding. Deals with different heats, stiff white heats, bending elastic and inelastic pieces, cold-short iron, good but unprofitable iron, tests, &c. Ill. 2500 w. Am Mach—Nov. 11, 1897. No. 16562.

MINING.

Accidents.

Compensation for Mining Accidents in Germany. Dr. Beumer in *Stahl und Eisen.* On the statistics published in the recently issued report of the Miners' Guilds (Mutual Aid) Assn. as to the accidents which have occurred in German mining during the nine years ending 1895. 2500 w. Ir & Coal Trds Rev—Oct. 29, 1897. No. 16508 A.

Dykes.

To Trace an Invisible Dyke. George H. Stone. Describes a new method by which the course of a dyke may be discovered from sand, rocks and boulder beds on the surface. 1700 w. Mines & Min—Nov. 1897. No. 16628 C.

Electric Locomotive.

The Electric Locomotive in Mining and Railway Work. Historical review with illustrations. 2200 w. Ir & Coal Trds Rev—Nov. 12, 1897. No. 16784 A.

Explosives.

Experiments with Explosive Gas Cartridges. (Ueber Versuche mit Knallgaspatronen.) Describing experiments with a compressed mixture of oxygen and hydrogen, to be used as a mining explosive. The charge is ignited by an electric spark, and safety, power, and freedom from noxious fumes are claimed. 1500 w. Glückauf—Nov. 6, 1897. No. 16483 B.

Fans.

Ventilating Fans. Discussion of a paper by W. G. Walker, read before the English Institution of Mechanical Engineers. 4000 w. Engng—Nov. 5, 1897. No. 16622 A.

Hydraulic Mining.

Some Notes on Hydraulic Mining. Augustus J. Bowie. Some of the difficulties encountered are mentioned showing how hazardous anticipated estimates of yield are. 2500 w. Eng & Min Jour—Oct. 30, 1897. No. 16264.

Hygrometry.

The Hygrometric Saturation of the Earth's Crust (Die Hygrometrische Sättigung der Erdrinde.) Discussing the various capacities for moisture of the different constituents of the earth's crust, with relation to the accumulation of water in mines. Two articles, 4500 w. Glückauf—Oct. 16, 23, 1897. No. 16482 E.

Machinery.

Electric Mining Machinery. J. N. Bulkley. Some investigations in regard to cost of operation in various mines. Figures obtained from mine officials. 5500 w. Mines & Min—Nov. 1897. No. 16630 C.

Mine Transmission.

See Electrical Engineering, Power.

Mining Law.

Proposed Change in Federal Mining Law. Address of W. S. Keyes before the California State Miners' Assn. on the amendments required to the existing statutes of the United States concerning mineral lands. 5500 w. Min & Sci Pr—Nov. 6, 1897. No. 16626.

The Ontario Mines Act. R. W. Raymond. Discusses some of the features. 1800 w. Can Min Rev—Oct., 1897. No. 16312 B.

The Proposed Revision of the United States Mining Law. R. W. Raymond. Editorial discussion of the improvements urged by Francis T. Freeland. 1100 w. Eng & Min Jour—Oct. 30, 1897. No. 15261.

Mining Methods.

Improvements in Prussian Mining Methods. From an official report published by the *Zeitschrift für Berg- Hutten- und Salinenwesen*, and reproduced by *Glückauf.* Part first deals with getting coal; the hand boring, rock drilling, explosives, wedging, laying-out and conduct of workings, timbering, pumping, hauling, &c. Ill. 4500 w. Col Guard—Oct. 22, 1897. Serial. 1st part. No. 16267 A.

Mining Region.

A Sketch of the Mining Fields of British Columbia and the Great Northwest. Arthur Lakes. Their geological formations, nature of the ore veins, location of placers, and physical features of the country; with some facts in regard to the production. 6800 w. Mines & Min—Nov., 1897. No. 16629 C.

New Zealand.

Progress of Mining in New Zealand. Henry A. Gordon. Abstract of presidential address delivered at the first meeting of the New Zealand Institute of Mining Engineers. Historical Review. 2800 w. Col Guard—Nov. 12, 1897. No. 16783 A.

Rackarock.

Is Rackarock Safe? Claiming that it has been proved a safe and suitable explosive for mining purposes. 1400 w. Aust Min Stand—Sept. 30, 1897. No. 16766 B.

Ratable Value.

Ratable Value of Mines. Discusses the letting of mines in England. 2400 w. Col Guard—Oct. 29, 1897. No. 16504 A.

Shaft Sinking.

McCulloch's Frame for Sinking Round Shafts. Illustrated description of a device enabling them to be sunk with economy and speed. 800 w. Engr, Lond—Oct. 29, 1897. No. 16514 A.

Sinking by the Poetsch Process at a Brux Lignite Mine. C. Petrlik. From a communication to the *Allgemeine Bauzeitung*, of Vienna. Describes a very difficult piece of work, caused by a thick bed of quicksand. Ill. 2500 w. Col Guard—Nov. 12, 1897. No. 16780 A.

Training.

The Training of Mining Engineers. Part first discusses why the present system, or systems, have not worked satisfactorily, or why they have served their time. The next paper will offer suggestions. 3500 w. Col Guard—Nov. 5, 1897. Serial. 1st part. No. 16651 A.

Ural.

The Ural Excursion of the International Geological Congress. Remarks on the localities visited which produced rare minerals and the more important mining centers. 3800 w. Engr, Lond—Nov. 12, 1897. No. 16732 A.

MISCELLANY.

Alloys.

Alloys. Chandler Roberts-Austen. First lecture on this subject, delivered before the Society of Arts, London, on March 15, 1897. It is the beginning of the fourth series on this subject, dealing with recent investigations and results. 4000 w. Jour Soc of Arts—Oct. 22. 1897. No. 16245 A.

Microscopic Study of Alloys. T. K. R. Explanation of the value of microscopic analysis of alloys, with illustrations. 900 w. Nature—Nov. 4, 1897. No. 16649 A.

Asbestos.

Diluvial—A New Form of Asbestos. Robert H. Jones. Read before the Asbestos Club, Black Lake. Information relating to this curious fibre and to its origin or formation. 3500 w. Can Min Rev—Oct., 1897. No. 16314 B.

Basic Slag.

A New Competitor for Basic Slag. (Ein Neuer Wettbewerb für die Thomasschlacke.) The magnetic separation of certain Swedish magnetic ores furnishes a quantity of apatite, which as a phosphate fertilizer bids fair to compete with slag from the Thomas basic steel process. 2000 w. Stahl und Eisen—Nov. 1, 1897. No. 16475 D.

Blowing Engines.

See Mechanical Engineering. Motors.

China.

China and Her Minerals. Perry F. Nursey. Considers the vast unutilized mineral wealth. Coal is the most abundant mineral. 1700 w. Ind & Ir—Nov. 12, 1897. No. 16777 A.

Geological Congress.

The International Geological Congress at St. Petersburg. Dr. Persifor Frazer. Interesting account of excursions arranged by the Russian government, which enabled geologists to get a clear idea of the extent and value of the mineral fields, with other interesting information. 2500 w. Eng & Min Jour—Nov. 20, 1897. No. 16723.

Hardness.

A New Indentation Test for Determining the Hardness of Metals. William Cawthorne Mervin. Reviews the methods previously used for determining hardness, and describes the author's method. Ill. 1500 w. Prac Eng—Oct. 29, 1897. Serial. 1st part. No. 16517 A.

Metallography.

Metallography as a Method of Research. (Die Metallographie als Untersuchungs Methode.) An important paper by M. Osmond upon the value of the study of etched sections in investigating the quality and nature of metal; presented at the International Testing Congress at Stockholm, 1897. 7500 w. Stahl und Eisen—Nov. 1, 1897. No. 16476 D.

Metals.

The Progress of Metallurgy and Metal Mining in America during the last Half-Century. James Douglass. Gives the history of these industries in Mexico, United States and Canada, considering each metal separately and the methods employed; also discussion. 138000 w. Jour Socy Arts—Nov. 26, 1897 No. 17000 A.

Mirrors.

Ancient Mirrors of Glass Backed with Metal. (Sur les Miroirs de Verre Doublé de Métal dans l'Antiquité.) Account, by M. Berthelot, of some interesting archæological specimens showing that the ancient Romans possessed the art of producing reflecting surfaces by backing glass with metal. 3000 w. Comptes Rendus—Oct. 4, 1897. No. 16432 B.

Nickel.

Reputed Nickel Mines in Minnesota. Horace V. Winchell. An account of fraud in a mining enterprise. 1600 w. Eng and Min Jour—Nov. 13, 1897. No. 16615.

Oil Wells.

Boring Oil Wells at Sea. Illustrated description of these wells on the sea shore near Santa Barbara, California. 800 w. Sci Am—Nov. 27, 1897. No. 16800.

The Caucasus Oil Field in 1897. Report of the adverse conditions which have so greatly affected the export trade. 700 w. Am Mfr & Ir Wld—Nov. 12, 1897. No. 16773.

Pumice Stone.

The Deposits of Volcanic Ash in Nebraska. E. H. Barbour. From a paper published in the report of the Nebraska State Board of Agriculture for 1896. Gives information of the extent, deposits, chemical composition, &c. Ill. 800 w. Eng & Min Jour—Nov. 6, 1897. No. 16388.

Rating.

Rating of Mines. Information of English law on this subject, with several cases illustrating contested points. 2000 w. Col Guard—Oct. 22, 1897. No. 16265 A.

Salt Wells.

The Great Salt Wells at Tsz-Lin-Ching. E. H. Parker. Description of these interesting wells in China, and the principle on which they are worked. 3600 w. U. S. Cons Repts—Nov., 1897. No. 16520 D.

Smelting.

The Smelting of Mixed Zinc and Iron Ores at Bethlehem, Pa. Josef von Ehrenwerth. Describes the process through which the ore is passed. 1100 w. Col Guard—Oct. 22, 1897. No. 16268 A.

Tin.

Tin Mining in Perak. A report of this district for 1896, and explanation of causes that lessened the output. 900 w. Ind Engng—Oct. 16, 1896. No. 16689 D.

Topography.

Geology in its Relation to Topography. John C. Branner. The origin and controlling factors of some of the more important topographic forms are pointed out, and the necessity of a knowledge of structural geology to the topographer, is shown. 8000 w. Pro Am Soc of Civ Engs—Oct., 1897. No. 16228 F.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

An Acetylene Gas Lamp for Bicycles. Illustrated description of lamp made by the George H. Clowes Mfg Co., of Waterbury, Conn. 700 w. Sci Am—Nov. 13, 1897. No. 16557.

An Italian Acetylene-Gas Generator. Describes the Sardi Generator, and illustrates it in sections. 700 w. Ind & Ir—Nov. 12, 1897. No. 16779 A.

Naphey's Automatic Acetylene-Gas Generator. Illustrated description of a machine which claims to remove all possibility of danger. 800 w. Met Work—Nov. 20, 1897. No. 16712.

The Acetylene-Gas Explosion. E. A. Gay. An account of the disaster in the shop of Valentine J. Long, Jr., at Rochester, N. Y. Ill. 855 w. Am Mach—Nov. 11, 1897. No. 16560.

Address.

President s Address at Meeting of American Gas-Light Association, at Old Point Comfort. Charles H. Nettleton. Touches on many subjects of interest to the gas industry. 5500 w. Pro Age—Nov. 1, 1897. No. 16306.

Burners.

Report of Burner Stoppages. Paul Doty. Read before the American Gas-Light Assn. Results of experience, experiment and research to discover the cause and cure of troublesome deposits. 7000 w. Pro Age—Nov. 1, 1897. No. 16307.

Boston, Mass.

Boston's Big Gas Project. From *Boston Daily Advertiser*. An account of the project to establish a great coke and gas manufacturing plant, giving the important features of the undertaking. 1000 w. Am Mfr & Ir Wld—Oct. 29, 1897. No. 16294.

Charging.

Charging Apparatus for Small Works. R. Watson. Read at meeting of Southern District Assn. of Gas Engineers and Managers, in England. Describes a method of scoop-charging. Discussion. Ill. 3300 w. Gas Wld—Nov. 13, 1897. No. 16776 A.

Consolidation.

Gas Interests Consolidating. Explains the gas situation in Chicago and in Greater New York. 1000 w. Bradstreet's—Nov. 6, 1897. No. 16340.

Cyanids.

Cyanids in Gas Manufacture. Herman Poole. Discusses the question of the quantity of cyanids from gas that is wasted, and how to remedy the matter. 3500 w. Am Gas Lgt Jour—Nov. 22, 1897. No. 16788.

Distribution.

Suggested Examinations in Gas Distribution. Norton H. Humphrys. Urging the proper inspection of the pipes and accessories for the supply and consumption of gas. 3000 w. Jour Gas Lgt—Oct. 26, 1897. No. 16357 A.

Gas Power Plant.

Tests Made on a Modern Gas Power Plant at a Textile Factory. An account of tests of a Thwaite gas generator of 300 I. H. P. capacity. Ill. 300 w. Elec Rev, Lond—Nov. 5, 1897. No. 16614 A.

Gas Power.

See Mechanical Engineering, Power and Transmission.

Gas Producer.

The Mond Gas-Producer Plant. Abstract of the discussion on paper by H. A. Humphrey, read at a meeting of the Institution of Civil Engineers. 7500 w. Col Guard—Oct. 29, 1897. Serial. 1st part. No. 16506 A.

The Mond Gas-Producer Plant and Its Application. Herbert Alfred Humphrey. Read before the Institution of Civil Engineers, England, March, 1897. Deals with recent advances in gaseous fuel, describes the Mond producer and recovery plant, giving tests, applications, etc., with tabulated data. Ill. 9600 w. Col Guard—Oct. 22, 1897. No. 16266 A.

The Mond Gas-Producer Plant. Discussion by correspondence of a paper by H. A. Humphrey, read before the Institution of Civil Engineers. 5000 w. Col Guard—Nov. 5, 1897. No. 16653 A.

Good Gas.

Why Good Gas? A. W. Wilkinson. Read before the Society of Gas Lighting. Discusses the various lights with which gas has had to compete, and the necessity of making the best gas even if it increases the cost. 1800 w. Am Gas Lgt Jour—Nov. 1, 1897. No. 16291.

Illuminant.

A New Illuminant. Reports an improvement in incandescent gas-burners, invented by Ernest Salzenberg, director of the gas-works of the city of Crefeld, Prussia. 200 w. Cons Repts—Dec., 1897. No. 16575 D.

Illumination.

Some Further Experiments on Interior Illumination. Alten S. Miller. Read before the American Gas Light Assn. A continuation of the study of this subject, giving results of experiments made. Short discussion. 1800 w. Am Gas Lgt Jour—Nov. 22, 1897. No. 16787.

The Illumination of Inclosed Space. W. H. Birchmore. Part first states the problem and the means of solving it, with review of progress in interior illumination. 4400 w. Am Gas Lgt Jour—Nov. 29, 1897. Serial. 1st part. No. 16887.

Leakage.

Leakage. J. M. Rusby. An outline of the methods employed and experience gained by the writer. Read before the American Gas Light Assn. 2400 w. Pro Age—Nov. 15, 1897. No. 16669.

Materials.

Unloading, Distribution, and Re-loading of Materials in Gas-Works. Mr. Meiklejohn.

Read before the Midland Assn. of Gas Managers, at Birmingham, Eng. Description of the most useful forms of the New Conveyor Company's plant at Smethwick. Ill. 2000 w. Jour Gas Lgt—Nov. 2, 1897. No. 16589 A.

Naphthalene.

A Method Successfully Employed to Obviate Trouble from Naphthalene. K. M. Mitchell. Read before the American Gas Light Assn. States the difficulties met with and the method that finally brought success. Also discussion. Ill. 3500 w. Am Gas Lgt Jour—Nov. 1, 1897. No. 16292.

Purifying.

A Quadruplex Purifying Box; Why Not? F. H. Shelton. Read before the American Gas Light Assn. Calls attention to objectionable features in the present design, with illustrated description of design of writer claiming to be a decided improvement. 5500 w. Pro Age—Nov. 1, 1897. No. 16308.

Chemical Notes on Purification. Henry A. Mather. Read at meeting of the Am. Gas Light Assn. Reviews the formulas of the reaction between sulphuretted hydrogen and hydrated oxid of iron, and considers methods of chemical treatment of iron purifying materials. 2400 w. Am Gas Lgt Jour—Nov. 15, 1897. No. 16609.

Retorts.

Retort Setting and Retort Heating. C. C. Carpenter. Read at meeting of Southern District Assn. of Gas Engineers and Managers, in England. Considers the method of heating by the supply and even distribution of fuel gas to be recommended, and discusses the problem generally. Discussion. 5000 w. Gas Wld—Nov. 13, 1897. No. 16775 A.

Rust.

Rust Deposits in House Pipes. F. B. Wheeler. Read at meeting of the Am. Gas Light Assn. Investigates what the rust consists of and where it comes from. Also discussion. 5500 w. Am Gas Lgt Jour—Nov. 15, 1897. No. 16608.

Stoking Machinery.

New Stoking Machinery at the Bury Corporation Gas-Works. Gives an account of a visit of inspection, by the Gas Committee, and of the new stoking machinery driven by compressed air. recently fitted to one section of the retort-house. 2000 w. Jour Gas Lgt—Oct. 26, 1897. No. 16358 A.

Water Gas.

Recent Advances in Lighting by Water Gas. Abstract translation of papers by H. Strache and H. Dicke, published in the *Journal für Gasbeleuchtung*. 3500 w. Jour Gas Lgt—Oct 26, 1897. No. 16359 A.

SEWERAGE.

Chicago.

Financial Statement of the Sanitary District of Chicago. Tabular statement to Oct. 1, 1897, showing that nearly $25,000,000 have been expended on this work. 700 w. Eng News—Nov. 11, 1897. No. 16570.

Disposal Works.

Some Considerations on the Designs of Town Sewerage Schemes. Frank Wood. Discusses the basis on which sewerage schemes are designed, with a note on the combined *versus* the separate systems. 4500 w. Engr, Lond—Nov. 12, 1897. No. 16730 A.

Pumping Machinery.

Sewage Pumping Machinery at Budapest, Hungary. O. N. Mueller, Jr., in *Zeitschrift des Vereines Deutscher Ingenieure*. Abstract translation by O. J. Marstrand. Illustrated description with results of official tests. 1000 w. Eng News—Nov. 4, 1897. No. 16363.

Separate Sewage.

The Advantages of the Separate Sewage System. W. M. Watson. Presents the superiority of the separate system to the combined system. 1400 w. Can Eng—Nov., 1897. No. 16607.

Sewer Construction.

Electric Navigation in a Sewer. Explains the numerous ways in which electricity was employed in the construction of a masonry sewer at Worcester, Mass. 1300 w. Eng Rec—Oct. 30, 1897. No. 16247.

Municipal Practice in Sewer Construction, Medford, Mass. T. Howard Barnes. Historical account of the work and the important details of the system. 2000 w. Eng Rec—Oct 30, 1897. No. 16249.

Sewers.

Laying Out Sewer Work. W. K. Hatt. Some notes descriptive of the field work in laying out sewer lines for construction, the operations of giving line and grade. 1700 w. Pro of Purdue Soc of Civ Engs—1897, No. 16810 D.

Test.

Test of Centrifugal Pump and Calibration of Weir at the Bridgeport Pumping Station, Chicago, Ill. R. C. Carpenter. Description of plant and of test made to determine the efficiency and capacity of the various pumps at the Sewerage Pumping Station at Bridgeport, Chicago, Ill. 5500 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16834 D.

Ventilation.

Sewer Ventilation. J. W. Hughes. Read before the American Public Health Assn. at Philadelphia. Opposing what is known as the intercepting trap, with reasons. 1300 w. Metal Work—Nov. 6, 1897. No. 16335.

STREETS AND PAVEMENTS.

Asphalts.

One Year's Work with a Chemical Laboratory for Testing Asphalts. George W. Tillson. An account of the work done at the laboratory in Brooklyn. 2500 w. Munic Engng—Nov., 1897. No. 16303 C.

Street Cleaning.

The Street-Cleaning Problem. J. W. Howard. Condensed from an address at the banquet of the Union League Club of Chicago. Contains much interesting information and discusses the cleaning of various cities, urging a larger appropriation for Chicago. 3500 w. Munic Engng—Nov., 1897. No. 16305 C.

Vienna.

City Improvements between the Park and Theatre in Vienna. (Die Regulirung des Stadttheiles vom Stadtparke bis zum Theater a. d. Wien.) Jos. Hudetz. A discussion of several plans for cutting new streets, and accompanying municipal improvements. The author offers a substitute plan for that of the city engineers of Vienna. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 22, 1897. No. 16410 B.

WATER SUPPLY.

Baltimore Mains.

Laying Large Water Mains in Baltimore. Describes some special methods of machinery used to promote economy and rapidity and prevent street obstruction. Ill. 800 w. Eng Rec—Nov. 20, 1897. No. 16726.

Cincinnati, O.

The New Cincinnati Water-Works. An account of a new intake to be built sufficiently above the mouth of the Miami to avoid all contamination except from remote cities and towns. Map. 1500 w. Eng Rec—Nov. 27, 1897. No. 16877.

Coating Pipes.

Coating of Cast-Iron and Steel Riveted Pipes. Condensed from the report of the special committee on coating of cast-iron and steel-riveted pipes. George H. Benzenberg, chairman to American Society of Municipal Improvements, at Nashville, Tenn. 3800 w. Munic Engng—Nov., 1897. No. 16304 C.

Danville, Illinois.

An Important Water-Works Decision. Text of an important decision of the Illinois Supreme Court, rendered by Chief Justice Phillips, maintaining that the city has no more right to break a contract than a private party. 2500 w. Eng Rec—Nov. 20, 1897. No. 16727.

Ground Water.

The Collection of Groundwater. (Ueber Grundwasserfassungen.) An investigation of the conditions which govern the accumulation of ground water and the formation of subterranean streams and pools, with special view to the use of such sources of water supply. 6000 w. Gesundheits-Ingenieur—Oct. 31, 1897. No. 16415 B.

India.

Bellary Water Supply—Copper Hills Scheme. Hormusji Nowroji. The conditions of this region in India are described, and the work being done, with costs of the Copper Hill supply. 1800 w. Ind Engng—Sept. 25, 1897. No. 16231 D.

Bellary Water Supply. D. McNeil Campbell. Brief discussion of the three schemes proposed. 1100 w. Ind Engng—Oct. 9, 1897. No. 16654 D.

New York.

The Water Supply of the City of New York. Information relating to the Forty-second street reservoir and the arrangements for abandoning it. 800 w. Fire & Water—Nov. 6, 1897. No. 16394.

Organisms.

Some Observations on the Growth of Organisms in Water Pipes. George C. Whipple. Discussion of this subject based on the biological observations made by the Boston Water Works, with the results. 5500 w. Jour N Eng Water Works Assn—Sept., 1897. No. 16591 F.

Petrolea, Ontario.

The Petrolea Water Works. Gives the plan adopted, describing the work. 2000 w. Can Eng—Nov., 1897 No. 16606.

Pumping Engine.

Pumping Engine, Fairhaven, Massachusetts. Illustrated description. 1500 w. Fire & Water—Oct. 30, 1897. No. 16259.

Purifying.

A Water Purifying Plant. Howard Stillman. The Clark process, adding milk of lime and carbonate of soda successively, is used at Port Los Angeles, Cal., successfully for purifying locomotive feed water. Details of apparatus and method are given. Ill. 4000 w. Trans Am Soc of Mech Engs—Dec., 1897. 16833 D.

Schuylkill River.

The Upper Schuylkill River. Oscar C. S. Carter. Describes the river and the conditions affecting it, as related to the water-supply of Philadelphia, Pa., and several towns along its banks. 4400 w. Jour Fr Inst—Nov., 1897. No. 16324 D.

Service Pipes.

Service Pipes Defects and the Remedy. George F. Chace. The writer believes the best service pipe at present in the market is tin-lined iron pipe. Gives account of experience. Discussion. 6000 w. Jour N Eng Water Works Assn—Sept., 1897. No. 16593 F.

Tower.

Standpipe and Tower at Lawrence. Illustrated description of a stand pipe enclosed in a stone and brick tower for the new high-service water system of this city in Massachusetts. 1400 w. Fire & Water—Nov. 6, 1897. No. 16393.

Water and Sewage.

Notes on Water Supply and Sewage Disposal in Massachusetts and Rhode Island. Information obtained on a recent short trip. 1600 w. Eng News—Nov. 25, 1897. No. 16843.

Water Purification.

The Purification of Drinking Water and Sewage. (Reinigung von Trink- und Abwasser.) A paper by Dr. Zirn of Hamburg, dealing mainly with the purification of sewage in order to avoid contamination of river water. 2500 w. Gesundheits-Ingenieur—Oct. 15, 1897. No. 16414 B.

Water-Works.

The Kowloon Water-Works. W. Cheetham. Brief description of these works in India, with costs. 800 w. Ind Engng—Sept. 25, 1897. No. 16230 D.

Woonsocket.

Woonsocket Water-Works Reservoir and Dam No. 3. Byron I. Cook. Illustrated description of this work in Rhode Island followed by discussion. 5500 w. Jour N Eng Water Works Assn—Sept., 1897. No. 16592 F.

MISCELLANY.

Cost of Service.

Cost of Service to Users and Taxpayers. Allen R. Foote. Read before the League of American Municipalities, Sept., 1897. Considers this the only proper basis of comparison to show the relative economic advantages derived from private and municipal ownership and operation of water, gas and electric-lighting works. Investigations made. 8800 w. Elec Eng, N, Y. —Nov. 4, 1897. No. 16329.

Garbage.

Disposal of Garbage and Refuse. Report of the committee on this subject, presented at the meeting of the American Public Health Assn. at Philadelphia. 4200 w. Eng Rec—Nov. 6, 1897. No. 16349.

The Disposal of Garbage and Refuse. Letters from James H. Fuertes and Rudolph Hering called forth by an editorial on this subject, published in this paper on Nov. 11, with editorial replies. 2800 w. Eng News—Nov. 25, 1897. No. 16842.

The Disposal of Garbage and Refuse. Rudolph Hering. An account of the cost of construction and operation of the Berlin, Germany, works. Ill. 3300 w. Eng Rec—Nov. 20, 1897. Serial. 1st part. No. 16725.

The Unsatisfactory Condition of Garbage Disposal in America. Editorial comment with criticism of the paper of Rudolph Hering, published in this journal on Nov. 4, 1897. 1200 w. Eng News—Nov. 11, 1897. No. 16573.

Healthful Construction.

See Architecture and Building, Construction and Design.

Hot Water.

Waste Heat Used. Describes an invention for heating water for public consumption. Utilizes the heat of street gas-lamps. Ill. 1800 w. Dom Engng—Nov., 1897. No. 16705 C.

Illuminants.

The Cost of Various Illuminants at Rouen in France. O. Piequet. Translated from the *Bulletin de la Société Industrielle de Rouen.* A résumé of data in this vicinity with notes relative to each method. 1800 w. Pro Age—Nov. 1, 1897. No. 16309.

Municipal Improvements.

General Taxation and Special Assessment for Municipal Improvements. N. P. Lewis. A consideration of the means of securing the money to pay for improvements, and whether they pay. 2500 w. Munic Engng—Nov., 1897. No. 16302 C.

Quarantine.

The Quarantine System of the United States. Walter Wyman. Describes the system showing the conditions which render it necessary, and explaining the regulations. 3800 w. San—Nov., 1897. No. 16577 D.

The Relation of Federal to State Quarantine. R. M. Swearingen. Read at conference of State Boards of Health, Nashville, Tenn., Aug. 18, 1897, and reprinted from the *Texas Medical Journal.* Reviews the law enacted in 1893, showing its defects. 2800 w. San—Nov., 1897. No. 16578 D.

Utility of Quarantines as Now Conducted—Inspection, Disinfection and Isolation Stations. F. Montizambert. Discussion at the meeting of the British Medical Assn., Montreal, concerning the points in which the regulations and usage of Canada differ from England. 1800 w. San —Nov., 1897. No. 16576 D.

Recreation Pier.

See Civil Engineering, Miscellany.

Transportation.

Plans for Increasing Transportation Facilities in and about New York; East River Transit. A discussion of the projects to bridge or tunnel the North and East Rivers, with information of the present standing of each scheme. Ill. 3400 w. Eng News—Nov. 18, 1897. No. 16709.

Waste.

The Disposal of Muncipal Waste. W. F. Morse. Gives an outline of methods and apparatus and some of the results. 3800 w. Pro. Age—Nov. 15, 1897. No. 16670.

RAILROAD AFFAIRS.

NEW CONSTRUCTION.

Africa.

Rhodesia and Its Railways. Interesting particulars of railway construction, the work of eighteen months covering a distance of 580 miles. 3300 w. Engng—Oct. 22, 1897. No. 16275 A.

Central America.

Central American Railway Enterprises. Brief account of the proposed transcontinental lines in Guatemala, Honduras, San Salvador, Nicaragua, and Costa Rica. 1800 w. Ry Age—Nov. 19, 1897. No. 16790.

China.

A Modern Railroad System for China. S. P. Butler. Interesting account of Sheng Ta-Jen and his influence in railway matters. 3300 w. Harper's Wk—Nov. 27, 1897. No. 16797.

Electricity.

Engineering Side of the Application of Electricity to Standard Railroading. A topical discussion of this subject. 4000 w. N. Y. R R Club—Oct. 21, 1897. No. 16590 D.

Gage.

The Relative Cost of Narrow and Standard Gage Railroads. Letter from M. N. Forney in reply to inquiry regarding first cost. Thinks there would be no difference if the rolling-stock was of the same character in each. 1800 w. Am Eng & R R Jour—Nov., 1897. No. 16238 C.

Japan.

Japanese Railways. Information on important points, obtained from official sources. Map. 1200 w. Engng—Oct. 29, 1897. No. 16389 A.

Klondike.

See Mining and Metallurgy, Gold and Silver.

Long Island Railroad.

The Electrical Equipment of the Suburban Service of the Long Island Railroad System. Illustrated description of the changes to be made by this road, and the equipment of a considerable part with electric traction apparatus. 1500 w. Elec Wld—Nov. 20, 1897. No. 16672.

Trans-Siberian Railway.

The Manchurian Extension of the Trans-Siberian Railway. Map with explanation, showing the advantage to Russia of this new location which carries this railway across Manchuria to Vladivostock. 600 w. Eng News—Nov. 11, 1897. No. 16569.

MAINTENANCE OF EQUIPMENT.

Brakes.

The Effect of Brakebeam Hanging Upon Brake Efficiency. R. A. Parke. Extracts from a paper presented at meeting of the New York Railroad Club. A careful study of the subject concluding that high efficiency of brakes can only be attained by suspending the brakebeams from the truck frame and between the wheels. 6000 w. R R Gaz—Nov. 19, 1897. No. 16695.

The Emergency Brake and the Garrison Accident. Editorial on the great saving of life due to the action of the emergency brakes. 700 w. R R Gaz—Nov. 19, 1897. No. 16697.

The Sargent Brakeshoe Tests at Wilmerding. Report of extensive road and laboratory tests of the new "Diamond S" brakeshoe. 2200 w. R R Gaz—Nov. 26, 1897. No. 16854.

Two Recent Improvements in Railway-Train Brake-Construction. The improvements discussed are the adaptation of the brakeshoe pressure to each truck, as described by R. A. Parke in a paper read before the N. Y. Railroad Club, and the improvement in construction as shown in the tests of the "Diamond S" brakeshoe. 1400 w. Eng News—Nov. 25, 1897. No. 16844.

Freight Trains.

Handling Freight Trains Partially Equipped with Air. Editorial discussion of paper of Mr. Nichols on this subject, read before the Central Assn. of R. R. Officers, at their July meeting. 2000 w. R R Gaz—Nov. 19, 1897. No. 16696.

Locomotives.

An Articulated Locomotive. Illustrated detailed description. The system is the invention of Mr. Haggans, and the locomotives constructed by M. F. Weidknecht, of Paris, are intended for use on light railways, on which steep gradients and very sharp turns have to be encountered. 700 w. Engr, Lond—Oct. 22, 1897. No. 16270 A.

Heavy Freight Locomotives—Buffalo, Rochester and Pittsburg Railway. Illustration, elevation and sections with descriptive specifications. 600 w. Ry Rev—Oct. 30, 1897. No. 16311.

Mineral Engine, Great Western Railway, England. An illustrated description of the most powerful goods engine working south of the Thames, with dimensions. 800 w. Engr, Lond—Nov. 5, 1897. No. 16643 A.

South-Eastern Railway Locomotives. A. E. Kyffin. Describes some of the older types of the various locomotives which came into the possession of this English road. Ill. 900 w. Mech Wld—Nov. 12, 1897. Serial. 1st part. No. 16768 A.

Steam-Pressure, Throttling and Expansion. Editorial discussion with suggestions as to superheating by use of higher steam-pressures. 1700 w. Am Eng & R R Jour—Nov., 1897. No. 16240 C.

Test of a Four-Cylinder Compound Locomotive—Eastern Railroad of France. M. Salomon, in the *Revue Générale de Chemins des Fer*. Descriptions of the tests, and of the engines tested. 1800 w. R R Gaz—Nov. 12, 1897. No. 16585.

The American Locomotive at Home and Abroad. Editorial on the growing export trade in locomotives, with criticism of an article which appeared in London *Engineering*. 1300 w. Ry Rev—Nov. 13, 1897. No. 16657.

The Locomotives Exhibited at the Second Bavarian Exposition in Nuremberg, 1896. A brief description of the eight locomotives exhibited, taken from a pamphlet on the subject by Eugene Brückmann. 2300 w. R R Gaz—Nov. 26, 1897. No. 16855.

Motor Car.

Steam Motor Car; New England Railroad. Illustrated description of a composite car the operation of which is being watched as an interesting experiment. 600 w. R R Car Jour—Nov., 1897. No. 16564.

The Patton Motor Car. Illustrated description with brief history and editorial. 3500 w. Ry Rev—Nov. 13, 1897. No. 16656.

Private Cars.

A Presidential Train. Illustrated description of handsome equipment built by the Pullman Company for the president of Mexico. 1300 w. Ry Age—Nov. 5, 1897. No. 16501.

President Diaz's Private Cars. Duane Doty. Illustrated detailed description of the fine cars recently built by the Pullman Co. for the Government of Mexico. 2800 w. R R Car Jour—Nov., 1897. No. 16563.

Sanitation.

The Sanitary Aspect of Railway Travelling and Rolling Stock. T. F. Strutt. Read at the Belgian Conference of Sanitary Inspectors. Criticizes the accommodations of local trains in England, and other conditions needing attention. 1700 w. Plumb & Dec—Nov. 1, 1897. No. 16658 A.

Weight Distribution.

The Distribution of Weight in Locomotives. (Die Gewichts-Vertheilung bei Lokomotiven.) An analysis of the distribution of weights upon drivers for various arrangements of axles, and discussion of best disposition of equalizing levers; by Inspector Leitzmann. 7000 w. Glaser's Annalen—Nov. 1, 1897. No. 16442 D.

MAINTENANCE OF WAY.

Dynamometer Car.

Car for Determination of the Resistance to Hauling. (Wagen zur Bestimmung der Widerstände bei Streckenförderungen.) An illustrated description of a dynamometer car used at Lens, Belgium. The pull on the draw bar is automatically registered upon a paper drum. 1000 w. 1 plate. Glückauf—Oct. 16, 1897. No. 16481 B.

Embankments.

The Sliding Embankments of the Hudson River Shore Lines. Archibald A. Schenck. Shows the limited extent and number of difficult places on the Hudson River lines, and explains the care taken in the construction. Ill. 1300 w. Sci Am—Nov. 13, 1897. No. 16558.

Frogs.

The Coughlin Swing-Rail Frog. Gives description with letter from C. O. Vandevanter, of the Western Maryland R. R., and illustrations. 1200 w. Eng News—Nov. 18, 1897. No. 16706.

Rails.

Welded Rails. (Les Rails Soudés.) Ch. E. Guillaume. An investigation of the effects of expansion and contraction upon continuous lengths of rails with solid welded joints. 2000 w. Moniteur Industriel—Sept. 25, 1897. No. 16493 F.

Railway Bridges.

See Civil Engineering, Bridges.

Station.

Columbus Union Passenger Station. Brief illustrated description. 400 w. R R Gaz—Nov. 12, 1897. No. 16588.

Superstructure.

Recent Investigations in Railway Superstructure Construction. (Neuere Versuche mit Oberbau-Constructionen.) An account by Prof. Birk, of experiments with various kinds of ballast, including the influence of frost, travel, material and other conditions. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 15, 1896. No. 16409 B.

Switch.

Switches with Unbroken Main Line Track for Siding Connections. (Weiche mit Ununterbrochenem Hauptgeleise für Abzweigung von Industriebahnen.) Describing several forms of switches by means of which railway siding connections may be made without interrupting the continuity of the main line rails. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 5, 1897. No. 16413 B.

Tracks.

Double-Track Construction. H. R. Safford. Describes a difficult piece of road to operate on the Illinois Central R. R. and the construction of a second track to improve the conditions. 2500 w. Pro of Purdue Soc of Civ Engs—1897. No. 16812 D.

SIGNALING.

Block Signals.

Automatic Block Signals on the Cincinnati, New Orleans & Texas Pacific. Illustrations and description. 1400 w. R R Gaz—Nov. 12, 1897. No. 16586.

Colored Signals.

Colors for Night Fixed Signals. Editorial on this subject from the point of view of the men who use the signals. 1800 w. R R Gaz—Nov. 26, 1897. No. 16858.

TERMINALS AND YARDS.

Railroad Shops.

Erecting Shop, Mt. Clare—Baltimore and Ohio Railroad. Illustrated description. 2000 w. Am Eng & R R Jour—Nov., 1897. No. 16237 C.

New Railroad Shops. Brief illustrated description of the plant of the Georgia and Alabama Railway at Americus, Ga. 800 w. Ry Age—Nov. 5, 1897. No. 16500.

Turn-tables.

An Arrangement for Increasing the Available Diameter of Turn-Tables. From the *Revue Générale des Chemins de Fer.* Description of an arrangement used by the Eastern Railroad of France for increasing the available diameter of their turn-tables. Ill. 600 w. R R Gaz—Nov. 26, 1897. No. 16857.

Three Examples of Recent Practice in Locomotive Turn-table Construction. Describes the hydraulic center-bearing table on the Chicago, Milwaukee and St. Paul Ry., recent practice on the Lehigh Valley Ry., and a pitless turn-table built by the Toledo Foundry & Machine Co. 2500 w. Eng News—Nov. 18, 1897. No. 16710.

TRANSPORTATION.

Accident.

Concerning the Latest Great Railroad Accident. H. G. Prout. Some remarks on the proper meaning of the word "accident," with a few comments on the accident near Garrisons, on the New York Central. 1200 w. Harper's Wk—Nov. 6, 1897. No. 16317.

Competition.

The New Problem in Transportation. Editorial discussion of electric-railroad competition for steam-railroad business. 1700 w. Am Eng & R R Jour—Nov., 1897. No. 16239 C.

Differentials.

Differential Rates and the Seaboard Air Line. T. J. Anderson. A letter to the editor explaining the grounds on which this company claims that it is entitled to differential passenger rates, with editorial. 2000 w. Ry Age—Nov. 12, 1897. No. 16623.

Earnings.

Railroad Earnings Showing Smaller Gains. Explains why the earnings for October in the United States, did not exhibit as large a gain over last year as preceding months showed, and gives tabulated statements of increases and decreases for past three years. 1600 w. Bradstreet's—Nov. 13, 1897. No. 16633.

Heavy Increases in Net Railway Earnings. Tabulated statements showing the improved operations during the third quarter of the year, with comments. 1500 w. Bradstreet's—Nov. 20, 1897. No. 16714.

Interstate Commerce.

See Economics and Industry, Governmental Control.

New York Stations.

Trains in and out of New York Terminal Stations. An interesting summary of the number of trains daily, on the various roads. 450 w. R R Gaz—Nov. 26, 1897. No. 16856.

Passenger Traffic.

Abuses of the Passenger Department. D. B. Martin. Address delivered at meeting of the General Passenger and Ticket Agents in St. Louis. 1300 w. Ry Age—Nov. 19, 1897. No. 16789.

Pooling.

Railway Pooling. George R. Blanchard. Considers the subject under eleven headings covering most of the phases. 3700 w. Ry Mag—Oct., 1897. No. 16604 C.

Railway Situation.

The Present Railway Situation. H. T. Newcomb. Gives a summary of the situation and enumerates some of the changes which the writer believes necessary to a satisfactory solution of the problem in America. 3300 w. N Am Rev—Nov., 1897. No. 16298 D.

Space Interval.

The Space Interval on a Single Track Railroad. Describes the method of working on the Cincinnati division of the Chesapeake & Ohio R. R., with graphical transcript of train sheet. 500 w. R R Gaz—Nov. 26, 1897. No. 16853.

Speed.

Continental Express Speeds and Accommodation. J. Pearson Pattinson. Part first refers to the Belgian state railroads. The information relating to gradients, locomotives, and the statistics of express speed are all taken from official sources and may therefore be deemed accurate. 1800 w. R R Gaz—Nov. 5, 1897. Serial. 1st part. No. 16372.

The Swiftest Trains of Europe. (Die Schnellsten Züge Europas.) A brief introduction, followed by a table of the fastest trains of the principal countries of Continental Europe, giving total length of run, time of run, maximum speed, and time consumed by stops. 1500 w. Glaser's Annalen—Oct. 15, 1897. No. 16439 D.

Suburban Railroads.

Electricity on Steam Suburban Railroads. S. H. Short. Reviewing briefly some of the features of the paper by N. H. Heft, read before the Am. St. Ry. Assn., with editorial. 2400 w. Elec Eng, N. Y.—Oct. 28, 1897. No. 16234.

Train Service.

The Past Summer Train Services. Editorial comment on the English and Scotch train service of the past season. 1800 w. Engng—Oct. 22, 1897. No. 16277 A.

Transportation.

Plans for Extending Transportation Facilities in and About New York—North River Transit. Presents the schemes under discussion for crossing the North River and the cause of their being thus far unable to secure the necessary capital. 3300 w. Eng News—Nov. 25, 1897. No. 16841.

MISCELLANY.

Address.

The Railways of America. M. E. Ingalls. An address delivered at Purdue University reviewing what the railroads have done for the nation, what they are, and what reforms are needed. 3500 w. Ry Age—Nov. 26, 1897. No. 16885.

China.

China and Her Railways. Perry F. Nursey. Information relating to past commercial enterprises, and the cause of their failure, with account of the efforts to introduce railways. 2300 w. Ind & Ir—Nov. 5, 1897. No. 16612 A.

The Chinese Railway Contracts. J. T. M. Information concerning terms of the famous Belgian contract which is said to have been rejected, and of Sheng Senn Wy, the Director-General of Railways. 3000 w. Ry Age—Nov. 26, 1897. No. 16884.

Electricity.

Application of Electricity to Railroads Now Operated by Steam Power. N. H. Heft. Full paper, with discussion, as presented before the American Street Railway Assn. The experience of the New York, New Haven and Hartford R.R. Co., giving results and conclusions that have been reached as to the best methods of applying electricity to heavy railroad work. 5600 w. St Ry Rev—Nov. 15, 1897. No. 16584 C.

European Railways.

Their Trains and Ours. Robert P. Porter. From *Boston Transcript*. Experiences of an American on European railways. 2000 w. Ry Rev—Nov. 20, 1897. No. 16767.

Employes.

Discipline of Employes. George H. Davis. Discussion of this subject with suggestions. Read before the American Street Railway Assn. 4400 w. St Ry Rev—Nov. 15, 1897. No. 16583 C.

Great Britain.

Railways and Railwaymen. Editorial discussion of the demands made by the Amalgamated Society of Railway Servants. 1300 w. Engr, Lond—Oct. 29, 1897. No. 16513 A.

Interstate Commerce.

Report of the Interstate Commerce Commission. Interesting information taken from this report with editorial comment. 800 w. Sci Am—Nov. 13, 1897. No. 16556.

Labor.

See Economics and Industry, Labor.

Metropolitan Railway.

The Ventilation of the Underground. Comments on the evidence given in the report of the Board of Trade of London, discussing the advisability of substituting electricity as a motive power, means of ventilation, &c. 3500 w. Trans—Oct. 29, 1897. No. 16398 A.

Narrow Gauge.

Narrow Gauge Steam Timber Roads in Galicia. (Ueber Schmalspurige Waldbahnen mit Dampfbetrieb in Galizien.) A. R. Fleischl. General description of a system of roads of 800 mm. gauge in the forests of Galicia, with topographical maps, profiles and details of rolling stock. Six plates, 7500 w. Mitt d Ver f d Förd d Local u Strassenbahnwesens—Aug., 1897. No. 16486 E.

The Wallücke Railway. (Die Wallückebahn.) Illustrated description of an 18 mile, 24 in. gauge steam road in Rhenish Prussia, with details of track and rolling stock. The road is mainly used for the transportation of iron ore. Three articles. 10,000 w. Die Schmalspurbahn —Oct. 1, 16, Nov. 1, 1897. No. 16490 H.

Ohio.

Pioneer Railroad of Ohio. Clark Waggoner. Interesting facts connected with the early history of railroading in this state. 1400 w. R R Gaz—Nov. 12, 1897. No. 16587.

Pacific Railroads.

The Pacific Railroads. Reviews the construction of the five roads extending to the Pacific, the competition, and the causes that have made their operation difficult. 1700 w. Engng —Nov. 5, 1897. No. 16619 A.

Prussia.

The Administration of Prussian Railroads. B. H. Meyer. A discussion of the Prussian system, with special reference to the adjustment of railway rates. 12000 w. An Am Acad—Nov., 1897. No. 16686 G.

Railways.

American Railways. Abstract of ninth statistical report of the interstate commerce commission, giving the estimated value of American railways as over $10,000,000,000. 1600 w. Bos Jour of Com—Oct. 30, 1897. No. 16243.

Railway Plans.

The Preparation of Parliamentary Plans for Railways. Harnett John Fuller. The aim of the author is to explain those methods which he has found to minimize errors. 2400 w. Engr, Lond—Nov. 5, 1897. Serial, 1st part. No. 16641 A.

Resistance.

Train Resistance. Editorial discussion of this subject, with suggestions for further investigations. 2200 w. Engr, Lond.—Oct. 22, 1897. No. 16271 A.

Secondary Roads.

The Utility of Secondary Roads. (Die Nützlichkeit der Secundärbahnen.) A thorough discussion of the commercial value of "feeder," or secondary roads operated in connection with main lines. 10000 w. Mitt d Ver f d Förd d Local u Strassenbahnwesens—Sept., 1897. No. 16487 E.

Venezuela.

Railroad Laws in Venezuela. A translation of the new law on railroad construction, which grants subsidies and other favorable concessions. 2800 w. Cons Repts—Nov., 1897. No. 16522 D.

STREET AND ELECTRIC TRAMWAYS.

Accumulator Traction.

Accumulator Traction in Cologne. C. H. Biggs, Jr. Information relating to the proposed change of power on what is said to be the best paying line in Germany. 1000 w. Elec Eng, Lond—Oct. 29, 1897. No. 16525 A.

Accumulator Traction on Rails and Ordinary Roads. L. Epstein. Part first reviews the causes that have delayed success in this field, and gives data concerning the system as applied at various places. 2000 w. Elec Eng, Lond—Nov. 12, 1897. Serial. 1st part. No. 16740 A.

Application of the Storage Battery to Electric Traction. Charles Hewitt. Read before the American Street Railway Assn. The full paper with discussion. Discusses the application of the battery direct to car or locomotive, to the ends of long lines, and to the powerhouse. Ill. 8000 w. St Ry Rev—Nov. 15, 1897. No. 16582 C.

Air Motors.

See same title under Mechanical Engineering, Compressed Air.

Basle.

The Basle Electric Tramway. Illustrated description of the electric tramway connecting the two railway stations in this city of Switzerland, and the difficulties arising from the narrow streets. 1200 w. Ry Wld—Nov., 1897. No. 16611 A.

Bridge Cars.

The Plans for Running Through Cars Over the Brooklyn Bridge. Plans showing final arrangements adopted, with explanation. 1000 w. Eng News—Nov. 18, 1897. No. 16707.

Budapest.

The Electric Railways of Budapest. (Die Elektrische Stadtbahnen zu Budapest.) A very full account of the surface and underground electric railways of Budapest, including photographs of power houses and portions of the subway. 7500 w. Elektrotechnische Zeitschr—Sept. 9, 1897. No. 16461 B.

The Francis-Joseph Electric Underground Railway at Budapest. (Die Budapester Elektrische Franz-Josef Untergrundbahn.) With plan of the lines and photographic views, together with sections of tunnel. 4500 w. Mitt d Ver f d Ford d Local u Strassenbahnwesens.—Sept., 1897. No. 16488 E.

Difficulties.

Some of the Difficulties Existing in the Construction and Operation of Electric Street Railways. G. W. Knox. Read before the American Street Railway Assn. The opportunities for economy in construction and operation are discussed. 4400 w. St Ry Rev—Nov. 15, 1897. No. 16581 C.

Edinburgh.

The Progress of Cable Construction in Edinburgh. Points brought into view during the conversion of the tramways to the cable system. Ill. 3300 w. Ry Wld—Nov., 1897. No. 16610 A.

Electricity.

See Railroad Affairs, Miscellany.

Electric Locomotive.

See Mining and Metallurgy, Mining.

Electric Traction.

Mechanical Features of Electric Traction. Philip Dawson. Portion of a paper read before the Institution of Mechanical Engineers, England, considering poles, insulators, trucks, motors, gearing, power, &c. 2800 w. Engr, Lond—Nov. 12, 1897. No. 16733 A.

Generators.

Some Features of Modern Electric Railway and Power Generators. Views of several generators of recent design, representing the best American practice, are given, with information concerning them. 2500 w. Eng News—Nov. 25, 1897. No. 16840.

Haulage.

See Mechanical Engineering, Power and Transmission.

History.

The Progress of Electricity on Railways During the Past Twenty-Five Years. W. Langdon. The progress traced is confined to work in Great Britain. Considers construction, materials, accessories, and applications. 4500 w. Elec Rev, Lond—Nov. 12, 1897. No. 16752 A.

Twenty-Five Years of Electric Traction. Philip Dawson. History of the development and progress. 3000 w. Elec Rev, Lond—Nov. 12, 1897. No. 16758 A.

Manchester, England.

See Electrical Engineering, Lighting.

Monorail.

The Portable Monorail Surface Road. (Le Monorail Portatif à Niveau du Sol.) Description of the Caillet system of one-rail portable railway for temporary agricultural and exploration service, with many illustrations of practical applications. 2500 w. 1 plate. La Revue Technique—Nov. 10, 1897. No. 16430 D.

Motor Car.

See Electrical Engineering, Power.

Mountain Road.

The Salève Electric Railway. (Chemins de Fer Electriques du Salève.) Description of a new third-rail electric rack railway from Veyrier to Treize Arbres, in Savoy. The road is about 4½ miles long, with a maximum grade of 25 in 100; the current is generated by water power. 2500 w. 1 plate. La Revue Technique. Oct. 25, 1897. No. 16429 D.

The Street and Mountain Tramway between Linz, Urfahr, and Pöstlingberg. (Die Strassen- und Bergbahn Linz-Urfahr-Pöstlingberg.) Illustrated description of this Austrian electric mountain tramway. The ascent is made by adhesion, with a uniform grade of 10 per cent. Map and profile. Two articles. 2500 w. Die Schmalspurbahn—Oct. 1, 16, 1897. No. 16489 G.

Municipal Ownership.

Municipal Ownership and Operation of Street Railways. P. F. Sullivan. Full paper as read at the Niagara Falls convention of the American Street Railway Assn. Unfavorable to its adoption in American cities at present. 7500 w. St Ry Rev—Nov. 15, 1897. No. 16580 D.

Norway.

The Electric Tramway of Bergen. (Die Elektrische Strassenbahn der Stadt Bergen.) An interesting description, with photographs, of the overhead trolley line at Bergen; the second electric road started in Norway. 2500 w. Die Schmal spurbahn—Nov. 1, 1897—Nov. 1, 1897—No. 16491 D.

Rapid Construction.

Construcotin of 2½ Miles of Electric Railroad Complete in 22 Hours. Describes the rapid work in building the road between Bound Brook and Somerville, N. J., by the New York and Philadelphia Traction Company. Ill. 2200 w. Elec Eng, N. Y.—Nov. 4, 1897. No, 16331.

Rapid Transit.

New York Rapid Transit Outlook. Considers the report of the Rapid Transit Commissioners favoring the building of the road, and the prospect of the work being undertaken in the near future. 1100 w. Eng Rec—Nov. 13, 1897. No. 16637.

Regulation.

A New Method of Regulation for Tramway Motors. (Ueber eine Neue Regulirung für Bahn motoren.) Prof. Blondel. The system consists in a combination of two electro motors with a storage battery and a special form of series parallel regulator. 3000 w. Elektrictechnische Zeitschr—Oct. 28, 1897. No. 16468 B.

Rights.

The Massachusetts Theory of Street Railway Rights and Privileges. From the *N. Y. Evening Post.* Discussion of the principle which should govern legislation regarding street railways, as stated by Charles Francis Adams, chairman of the committee of investigation in the part of the State. 1400 w. Elec Eng, N. Y.—Nov. 25, 1897. No. 16850.

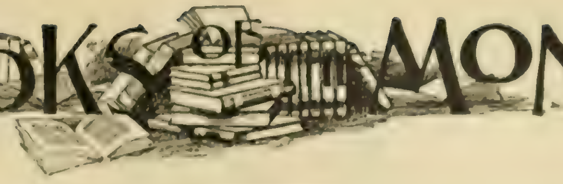
Suburban Railroads.

See Railroad Affairs, Transportation.

Transportation.

See Municipal Engineering, Miscellany.

BOOKS OF THE MONTH



LE MÉCANISME DU LIT FLUVIAL. Par V. Lokhtine, ingénieur des voies de communication. St. Petersbourg: Bureau Technique International, 1897.

M. Lokhtine, who is the director of roads and navigable waterways in the government of Kazan, has prepared this essay to discuss the nature, from a mechanical standpoint, of rivers considered in their entirety. As he rightly says, in existing treatises we look in vain for a discussion of the general physical properties of a river, finding, instead, a treatment of particular cases, each different from every other. When, for example, we desire to examine why one portion of a stream has a deep and permanent bed, while another has always an uncertain and shifting bottom, we find no investigations to aid us, although there must be some law governing the mechanical actions at work. It is to the solution of these problems that this eminent Russian specialist has devoted himself, and to hydraulic engineers especially his work will be found a valuable contribution to engineering physics.

The author considers the course of every river to be based upon three fundamental factors: 1, the volume of flow, depending upon climatic conditions, and upon the nature of the country traversed; 2, the slope, governed by the general relief of the area through which the river flows; 3, the nature of the material of the river-bed, considered in view of its greater or less destructibility under the action of the water.

These three factors determine completely the character of a river, and give the characteristic properties which distinguish it from other streams; and it is upon these, as a foundation, that M. Lokhtine bases his discussion.

The data used in the work are naturally obtained mainly from observations upon the rivers of Russia, including the Volga, Dnieper, Don, Vistula, Niemen, Dwina, and others, and the observations of Baumgarten on the Garonne and the Lot are also included. The questions of stable and unstable equilibrium, so to speak, of a river-bed are shown to depend upon the relative preponderance of slope to resistance of material, and these again are modified in times of high or low water. While the data at present collected are hardly in shape to permit of reduction to mathematical form, the obedience of the forces to law is shown and sustained.

Profiles of portions of the Volga are given, and plans of certain of its shallows, together with maps showing the changes in the bed of the Amon-Daria at the point where it is crossed by the Trans-Caspian railway.

While the subject is far too vast to be exhausted in such a work as this, M. Lokhtine has approached it in the true scientific spirit, and broken the way for others.

THE ELEMENTS OF ELECTRO-CHEMISTRY Treated Experimentally. By Dr. Robert Lüpke. Translated from the second revised and enlarged edition, by M. M. Pattison Muir, M. A. London: H. Grevel & Co., Philadelphia: J. B. Lippincott Co. 1897. Cloth.

Notwithstanding the long time which has elapsed since the art of electroplating has been practised, the development of the general science of electro-chemistry has by no means kept pace with the progress of electrical science in general, and it is only within a few years, that electro-chemistry has begun to receive the attention which its importance demands.

The greatest development of the science has taken place in Germany, and it is from Germany that the best treatises on the subject must come, at least for the present. Although the efforts of the leading students of the science have been largely devoted to the establishment of the theoretical principles of electro-chemistry, it is upon experimental investigations that this work must be based, and Dr. Lüpke's work, as its title indicates, discusses the experimental side of the questions very fully.

The work is divided into three parts, of which the first is devoted to recent theories of electrolysis, the second discusses van't Hoff's theory of solutions, and the third treats of the osmotic theory of the current of galvanic cells.

In the first section the work of Hittorf, Kohlrausch, Arrhenius, Ostwald, Grotthus, and others is treated; and such subjects as the motions of the ions, and the theory of transport numbers as discovered by Hittorf, and the dissociation theory of Arrhenius, are discussed in a manner until now not accessible to English students.

There is no doubt that this entire subject of electro-chemistry is destined to play a most important part both in the researches of pure science and in the technical applications to the arts, and, in view of the meagre information until now accessible in the English, this translation of Dr. Lüpke's standard work is especially acceptable.

The work of translation appears to be well done, and the book is well printed and illustrated.

AMERICAN AND OTHER MACHINERY ABROAD. Being a study of the European field for the introduction of American machinery. By Fred J. Miller. New York. American Machinist, 1897. Flexible linen.

This reprint of Mr. Miller's letters to the *American Machinist* forms very interesting reading, not only from the fact that it gives much information to builders of American machinery about the conditions which tools for use in other countries must meet, but also because it is written in a bright and entertaining manner, about many things which the general traveller utterly fails to observe.

Some of the points made by Mr. Miller as to the ways and methods of English workmen are instructive reading, in view of the contest of the A. S. E., which, although not on when the book was written, includes some of the questions that strike the eye of an American immediately.

There is little doubt that one of the greatest obstacles which American tools are to meet in England is the opposition of the workmen to the so-called "intensive" methods of production, and it will surely be very difficult for the employers to get the output from the American tools which they were constructed to furnish. The opposition of the men to tools which enable one man to do the work of ten without actually laboring any harder, or which turn out better work with an unskilled attendant than the most experienced machinist could do, will be a very difficult thing to overcome.

The writer wishes, in justice to English administrative methods, to compare his own experience at Woolwich arsenal with that of Mr. Miller. Although a parliamentary inquiry was impending about some special work, one English friend introduced three Americans, who, indeed, were detained a few minutes upon their announcement of nationality, but, after they had registered and stated officially that nothing would be published which might be seen, were passed into the arsenal without more than five minutes' delay.

Mr. Miller spent some time in continental Europe, going as far as Russia, but for this and much other interesting matter we must refer all who are interested in the subject of American machinery abroad to the full perusal of his entertaining little book.

LETTERING FOR DRAFTSMEN, ENGINEERS, AND STUDENTS. By Charles W. Reinhardt. Third Revised Edition. New York: D. Van Nostrand Company, 1897. Oblong boards.

The art of constructing elaborately-lettered titles for engineering and mechanical drawings bids fair to become one of the lost arts, and one to which we can bid farewell most cheerfully, sending it to keep company with the classic or gothic architecture which formerly played so important a part in machine frame-work, or with the beautiful brush-work which shaded the swelling contours of many of the elaborate drawings of a past generation. Even for working drawings. the plain block letter which every draftsman should know how to make is becoming less necessary, since in most well-regulated drawing-rooms in the United States at least the titles are now appended by some of the mechanical printing processes of recent introduction, at the same time saving the draftsman's labor and furnishing occupation for the office-boy.

Mr. Reinhardt's book, however, is

mainly for another line of work, and one which is by no means so likely to be superseded, since the greater portion of his work is devoted to the art of making neat and legible inscriptions upon the drawings themselves. In this line the author has had much experience, as the draftsman for *Engineering News*, and, as a consequence, his work is especially adapted for use in connection with the lettering and figuring upon drawings intended for reproduction and illustration. For this, the book is certainly to be recommended, and we must say that there is infinitely more style and effect in the neat outline system so well shown and explained in this system than in the German "*Rundschrift*" which has found vogue in some quarters.

The fact that the work has reached its third thousand is ample evidence that it is meeting with popular appreciation.

PHYSICAL PROBLEMS AND THEIR SOLUTION. By A. Bourgougnon. New York, D. Van Nostrand Co. 1897. Boards, 50 cents.

This latest addition to Van Nostrand's Science Series contains a number of worked-out problems in elementary physics, evidently intended to supplement the shortcomings of the usual text-books of physics.

Practical examples in mechanics, hydrostatics, pneumatics, acoustics, and heat are given, and a few problems in electricity, while an appendix includes a set of problems given at examinations by the University of the State of New York.

BOOKS RECEIVED.

The Elementary Principles of Machine Design. By J. G. A. Meyer. New York: The Industrial Publication Co.

Ninth Special Report of the Commissioner of Labor. The Italians in Chicago. A Social and Economical Study. Prepared under the direction of Carroll D. Wright, commissioner of labor. Washington, U. S. A.: Government Printing Office.

How to Build a Home. The House Practical. Being suggestions as to safety from fire, safety to health, convenience, durability, and economy. By Francis C. Moore. New York: Doubleday & McClure Co.

Le Mécanisme du Lit Fluvial. Par V. Lokhtine, ingénieur des voies de communication. St. Pétersbourg: Bureau Technique International.

Report of Paving-Brick Commission. National Brick Manufacturers' Association of the United States of America. Standard Paving-Brick Tests, and Methods for their Conduct. Published for the Association by T. A. Randall & Co., Indianapolis, Ind., U. S. A.

The Architects' Directory for 1897–98. New York: William T. Comstock.

The Essentials of Gearing. A Text-Book for Technical Students and for Self-Instruction. By Gardner C. Anthony. Boston, Mass., U. S. A.: D. C. Heath & Co. Cloth, $1.50.

The Elements of Electro-Chemistry. Treated Experimentally. By Dr. Robert Lüpke. Translated by M. M. Pattison Muir, M. A. London: H. Grevel & Co. Philadelphia, Pa., U. S. A.: J. B. Lippincott Co. $2.50.

Physical Problems and Their Solutions. By A. Bourgougnon. New York: D. Van Nostrand Co. 50 cents.

Euclid: Books I–IV. By Rupert Deakin, M. A. University Tutorial Series: London: W. B. Clive; New York: Hinds & Noble. The Tutorial Trigonometry. By William Briggs, M. A.; F. C. S., F. R. A. S., and G. H. Bryan, Sc. D., F. R. S. The University Tutorial Series. London: W. B. Clive; New York: Hinds & Noble.

American and Other Machinery Abroad. Being a Study of the European Field for the Introduction of American Machinery. By Fred. J. Miller. New York: American Machinist.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Matthews & Yates, Ltd., Cyclone Works, Swinton, Manchester, England. = Catalogue entitled "Ventilating and Electrical Specialities," containing information of interest to the engineer. It includes dimensions, prices, and other data of the "Swinton" dynamos and motors, wound in series, shunt, or compound; "Cyclone" electric blowers and exhausters, with inlet diameters from 5 inches to 27 inches; and of the "Cyclone" electric fans, 12 to 60 inches diameter. The catalogue is excellently printed and illustrated in half tone.

Spencer & Co., Melksham, Wilts, England.= Catalogue of their methods of loading and handling grain, seed, etc.

James Rigg, 11 Queen Victoria St., London.= A small catalogue of patent machinery for tipping coal.

W. H. Bailey & Co., Albion Works, Salford, England.=New catalogue dealing with steam-engine and boiler fittings, in which almost every conceivable device is illustrated and priced. The catalogue is entitled "Bailey's Useful Inventions for Engineers."

The Sturtevant Engineering Co., 75 Queen Victoria St., London, E. C.=Catalogue No. 14 of the Cutler-Hammer motors, starting-switches and speed regulators. The Cutler-Hammer automatic action in starting-switches has the object of shielding the motor from harm when, through accident or carelessness, the current is interrupted or the motor is overloaded. The catalogue contains illustrations accompanied by short descriptions.

R. W. Paul, 44 Hatton Garden, London, E. C. =Descriptive catalogue with illustrations and prices of a number of resistance boxes, galvanometers, voltmeters, and electrometers.

Armstrong, Stevens & Co., Whitall St., Birmingham, England.=Catalogue showing a large number of different forms of drop forgings and bolts.

The Vauxhall Iron Works Co., Ltd., Wandsworth Rd., London.=Catalogue describing the Dayton pistonoidal slide-valve, which, it is stated, combines the features of the ordinary D valve with those of the piston valve.

G. G. Blackwell, Sons & Co., The Albany, Liverpool, England.=(*a*), Pamphlet dealing with special alloys largely used by steel makers and founders; (*b*), Pamphlet, on "prepared manganese."

Downie & Adams, 24 Newman St., London.= Catalogue giving details of the Brillié meters, recording up to 10,000 watts on the two-wire system, and up to 20,000 watts on the three-wire system.

Messrs. Yates & Thorn, Blackburn, England.= Illustrated catalogue of steam boilers and accessories, compiled by W. H. Fowler, supplemented by articles and explanatory details making it valuable as a source of information. The book has a most complete index and the text is accompanied by 155 figures. The first fifty pages are given up to the principles of steam-boiler construction and evaporative efficiency, the remaining 100 pages to various types of boilers made by Messrs. Yates & Thorn, including the vertical, multitubular and Fairbairn and Elephant types. The catalogue also includes details of boiler-feed pumps, boiler fittings, and bridge and girder work.

Baldwin Locomotive Works, Philadelphia, Pa., U. S. A.=Illustrated catalogue of narrow-gage locomotives, with special reference to the Japanese trade. 450 pages, illustrated by half tone and sectional views. The first part gives a history of the firm, followed by a catalogue of various types of narrow-gage locomotives, accompanied by specifications and instructions for cabling orders. The latter part of the book is almost entirely given up to drawings, details, and code for ordering various parts of locomotives.

Sturtevant Engineering Co., 75, Queen Victoria Street, London, E. C.=Catalogue No. 100, in French, entitled Catalogue Général Illustré des Ventilateures Sturtevant, octavo, paper, 42 pages, well printed and illustrated, and carefully prepared by an engineer acquainted with technical French. This catalogue contains details of the numerous varieties of Sturtevant ventilators, gas exhausters, heaters, etc., of general and special make, also pulleys, registers, etc., adapted to use with the Sturtevant machines.

Walter George Atkins, C. E. 27, Agamemnon Road, West Hampstead, London, N. W.=Circular on "The Modern System of Water Purification, or the Perfection of the Lime Process of Softening," 4 pages.

Bullivant & Co., Ltd., 72, Mark Lane, London, E. C.=Pamphlet on "Wire Mining- and Hauling-Ropes: Their Construction and Uses, Embracing Aerial Ropeways," by J. Bucknal Smith, C.E., author of "Wire: Its Manufacture and Uses," etc., being an abstract from "The Mining Journal," 1897, large octavo, paper, 32 pages, with a number of full-page and other illustrations of plants constructed by Messrs. Bullivant & Co., Ltd., and of their appliances. The pamphlet treats clearly and interestingly of some historical points in the manufacture of wire and in the employment of wire ropes; of the vexed questions of gages, at least partially settled finally by the establishment of the "standard wire gage," and the millimeter gage; and of the modern methods and results of Messrs. Bullivant & Co., Ltd. It concludes with descriptions of varying Bullivant installations now in operation.

R. White & Sons.=Reprints of articles containing well-illustrated descriptions of light-railways, with special reference to the system of Messrs. R. White & Sons.

William O'Brien, 21 Ibrox Terrace, Glasgow. =Illustrated circular sheet, containing description of Mr. O'Brien's patented apparatus for closing water-tight doors on ships's bulkheads, automatically or by hand, thus insuring greater security for life at sea.

Worthington Pumping Engine Co., 153 Queen Victoria Street, London.=General catalogue of Worthington pumping machinery, illustrating and describing most excellently a remarkable variety of pumps, and of meters, pump-connections, pressure regulators, marine feed-water heaters and cognate appliances. Among the many new types of pumping-machinery catalogued are to be noted the vertical ballast pump, sinking pump, vertical twin-cylinder air pump, direct-connected electric pump, electric power pump, and steeple pumps. The catalogue is admirably codified and indexed, and gives much serviceable information in formulas, tables of steam- and water-pressures, frictional losses, etc.

R. D. Wood & Co., Philadelphia, Pa., U.S.A. =Illustrated catalogue of hydraulic tools, cranes, and machinery, including valves, intensifiers, shears, punches, rivetters, and lifts. The machinery is much of it illustrated from actual service installations, and represents all types and sizes up to the largest travelling and jib cranes. A supplement contains some illustrated advertisements of gas and waterworks appliances.

James Leffel & Co., Springfield, Ohio, U. S. A.=New catalogue of turbine wheels, extensively and effectively illustrated; the illustrations are almost all taken from actual installations, some of them very large. Besides the description of the Standard, Special, and Samson wheels, and the very full accompanying tables of efficiency and capacity, the catalogue has an unusual amount of information concerning measurement of water-powers, head-pipes, head-gates, penstocks, water-wheel power-connections, power transmission, and other problems connected with the installation and management of water-power.

Merchant & Co., New York, Philadelphia, and Chicago, U. S. A.=Catalogue of Merchant's Spanish tiles and Gothic shingles, made of copper, galvanized iron, zinc, and terne plates. The catalogue is devoted to description of the metal tiles, the mode of laying, illustrations of special forms, and photo-engravings of buildings on which they are in use.

The C. W. Hunt Co., New York.=Catalogue "No. 9710," manila rope for transmission and hoisting. With excellent illustrations of rope manufacture, knots, splices, and rope-drives and driving machinery, as well as transmission diagrams, tables, formulæ, and other data. With its appendices from technical journals, the catalogue, in fact, constitutes a brief treatise for engineers on ropes for transmission of power.

The Contractors' Plant Mfg. Co., Buffalo, N. Y.=Illustrated catalogue, for 1897–98. An excellently-designed book of 140 pages, filled with engravings and descriptive text and data concerning steam-, horse-, and hand-power hoisting machinery—wheels, derricks, blocks, sheaves, contractors' plows, cranes, wire cable and guy-rope, and contractors' supplies. Fully indexed.

Edison & Swan United Electric-Light Co., Ltd., London.=Handsome illustrated covered catalogue of the company's exhibit at the Imperial Victorian Exhibition, Crystal Palace, 1897. Concludes with illustrations and description of lamps in many styles, switches, dynamos, and motors.

The Pratt & Whitney Co., Hartford, Conn., U. S. A.=Descriptive and illustrated catalogue, making a small, stiff-covered book of 400 pages, with engravings, descriptive text, and dimensions of every variety of lathes, boring and drilling machines, milling machines, planers, shapers, and American machine tools of the latest design for all purposes, general and special. In fact, a compendium of American machine-tool practice.

A. S. Gear, New York.=Small illustrated catalogue of hydrants, especially the flush pattern, which is placed beneath the sidewalk. The information is well condensed, and the cuts clearly indicate the construction of the hydrant.

Illinois Steel Co., Chicago, Ill., U. S. A.=(*a*) Small pamphlet devoted to steel portland cement, giving tests of the cement by high authorities, and testimonials from engineers who have used it in important work; (*b*) illustrated folder, presenting similar matter in condensed form.

The New Era Iron Works Co., Dayton, Ohio, U. S. A.=Well-illustrated catalogue of gas and gasoline engines, of various types and sizes.

Thorpe, Platt & Co., New York.=Illustrated folder of Geipel's steam trap, for high- or low-pressure steam, with sectional drawings, and list of sizes and prices.

John W. Hartman, Bethlehem, Pa., U. S. A.= Illustrated folder of the Hartman automatic regulator, for preventing the accumulating of air in pressure pipes.

The Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., U. S. A.=(*a*) Illustrated catalogue (Section E) of foot presses, drop presses, and screw presses. The engravings are good, and the accompanying text and data brief and pointed; (*b*) supplementary folder of portable, bench, and four-poppet drop presses; (*c*) leaflet of hydraulic press and vertical milling-machine.

Boston and Lockport Block Co., Boston, Mass., and Lockport, N. Y.=Handy illustrated catalogue of tackle blocks, sheaves, differential hoists, diaphragm, pumps, warehouse trucks, cant-hooks, jacks, etc.

U. S. Wind Engine & Pump Co., Batavia, Ill., U. S. A.=Handsomely-illustrated catalogue of wind-mills, towers, pumps, artesian-well supplies, and irrigation specialties. Also of power pumps, valves, reducers, fittings, and tools.

The Railroad Supply Co., Chicago, Ill., U. S. A.=(*a*) Illustrated catalogue of "items of interest on ties and tie plates;" engravings of protected and unprotected ties, made from samples in actual service; (*b*) catalogue of the "Chicago" railroad-crossing signal; (*c*) illustrated folder of the anchor tie-plate guard-rail brace.

The Deane Steam-Pump Co., Holyoke, Mass., U. S. A.=Descriptive catalogue of the Deane steam and power pumps and pumping machinery: octavo, 132 pages, in card-board cover, well printed and with superior illustrations. This catalogue provides a telegraphic ordering code, including a code word for every size and capacity of pump manufactured by the company; it has also a chapter of useful information and tables of equivalents of various weights and measures, areas of circles in inches, friction of water in pipes, factors of evaporation, properties of saturated steam, etc.

M. T. Davidson, 45 Keap Street, Brooklyn, N. Y.=(*a*) Illustrated catalogue of steam pumps for all kinds of service—water works, boiler-feeding, mining, fire, tanneries, artesian and deep wells, etc.; also of air and circulating pumps, acid pumps, vacuum pumps, blowing engines, evaporators, packing and accessories. An appendix gives tables of useful data of area, contents of cylinders, pressure of water and steam, and hydrant and hose streams. (*b*) Leaflet of White's cooling tower and evaporative condenser.

The Fellows Gear-Shaper Co., Springfield, Vermont, U. S. A.=Illustrated catalogue on heavy cardboard, stating briefly, but clearly, the merits of a gear-shaper which is said to cut a theoretically-correct tooth.

The Graves Elevator Co., Rochester, N. Y.=Special illustrated catalogue of passenger and freight elevators, of hydraulic, electric, belt- and gear-driven screw types; also of elevator cars and safety appliances.

General Electric Co., Schenectady, N. Y.=Handsomely-illustrated catalogue, entitled "Operation of Electric Mining Plants," and consisting essentially of brief general accounts of actual installations with testimonials from the companies using them.

Manhattan Electrical Supply Co., New York.=Illustrated catalogue of 300 pages, devoted to electric-light, household, telephone and telegraph supplies—batteries, push-buttons, switches, bells, gas-lighters, lamps, brackets, induction coils, and similar apparatus.

Newton Machine-Tool Works, Philadelphia, Pa., U. S. A.=Catalogue "No. 33," 180 pages, illustrated, descriptive of a large line of planing, shaping, drilling, cutting-off, milling, slotting, and other general and special machine-tools.

Electric Appliance Co., Chicago, Ill., U. S. A.=General catalogue No. 6; a large cloth-bound volume of nearly 600 pages, well printed, illustrated, and indexed; the apparatus described and listed includes every variety of appliance for transmission and application of electricity, especially in its lighter uses.

F. J. Collin, Leeds, England.=Circular and leaflet of Collin's patent coke-ovens, with list of installations of this type since 1890.

The Knickerbocker Engine Works, Hartford, Conn., U. S. A.=Illustrated catalogue of the Knickerbocker engine, a horizontal engine of peculiar form occupying very small space. Photo-engravings of sectional drawings and of several types of completed engines are given in connection with the text.

Chas. E. Parker, Orange, Texas, U. S. A.=Descriptive catalogue of the Parker Safety water-tube boiler, illustrated by line cuts of the boiler under construction and completed.

The Philadelphia Bridge Works, Pottstown, Pa., U. S. A.=Illustrated catalogue of deck and half through turntables, with descriptive text, list of duplicate parts, and reference to railways using these turntables.

Richards & Co., New York and Chicago.=Catalogue and price-list of chemicals.

Brentano's, Paris, New York, and Chicago.=Catalogue of new publications and new editions, with mention of German, French, and Italian departments and subscription department for periodicals.

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THE GOLD MINES OF THE WITWATERSRAND, SOUTH AFRICA.

By John Hays Hammond.

I.—THEIR RAPID DEVELOPMENT, AND THE GEOLOGY OF THE REGION.

IN the northern part of the South African Republic (Transvaal) is situated the Witwatersrand mining district, embracing an area of 1,200 square miles.[*] It is connected by railway with the seaports of Cape Town, Durban, and Delagoa Bay,—1,013, 483, and 377 miles respectively. The Witwatersrand occupies a portion of the high plateaux of South Africa at an elevation of from 4,200 to nearly 6,000 feet above the sea-level. This elevation countervails the debilitating influence of its tropical latitude, imparting to the country a climate of unexcelled salubrity. It is, however, too true that the death-rate of certain parts of the district is abnormally high, that of Johannesburg reaching 59 deaths per 1,000 in the year 1895. But this high mortality is attributable solely to the wretched hygienic conditions that obtain. These conditions are susceptible of betterment by good government, and with improved sanitation, etc., Johannesburg would be a veritable sanatorium.

The physical aspect of the country is strikingly like the western plains of America, somewhat less regular in its undulations perhaps, but almost equally destitute of indigenous trees.

In the vicinity of Johannesburg, the chief emporium of the country, is a ridge of quartzite, with an easterly and westerly trend. This ridge is known as the Witwatersrand, or White Waters Range, and gives the name to the district. It forms the water-shed between

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[*] The term Witwatersrand is locally more limited in application, being the name of one of several districts, which together include all the auriferous banket fields of the Transvaal.

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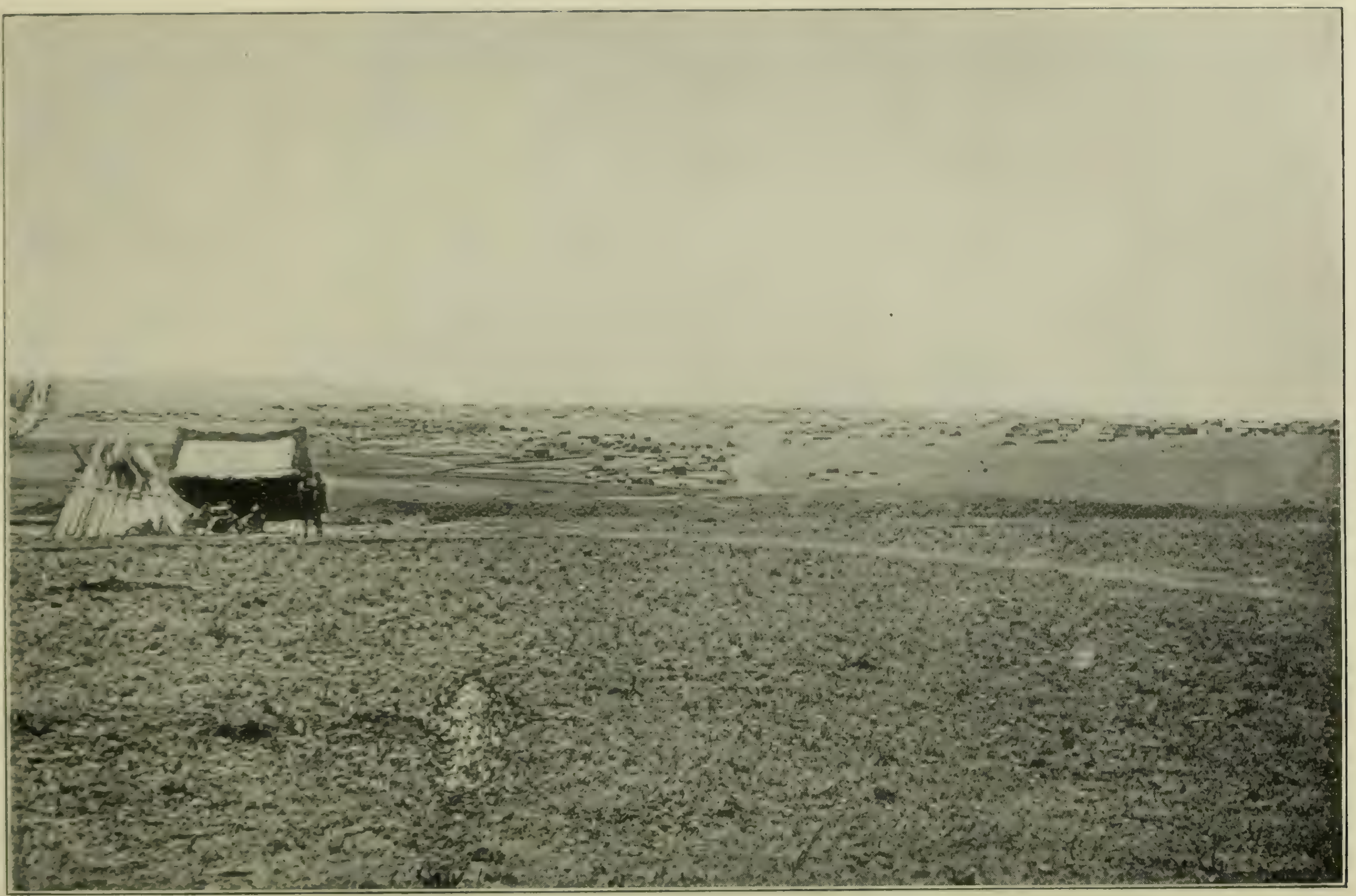
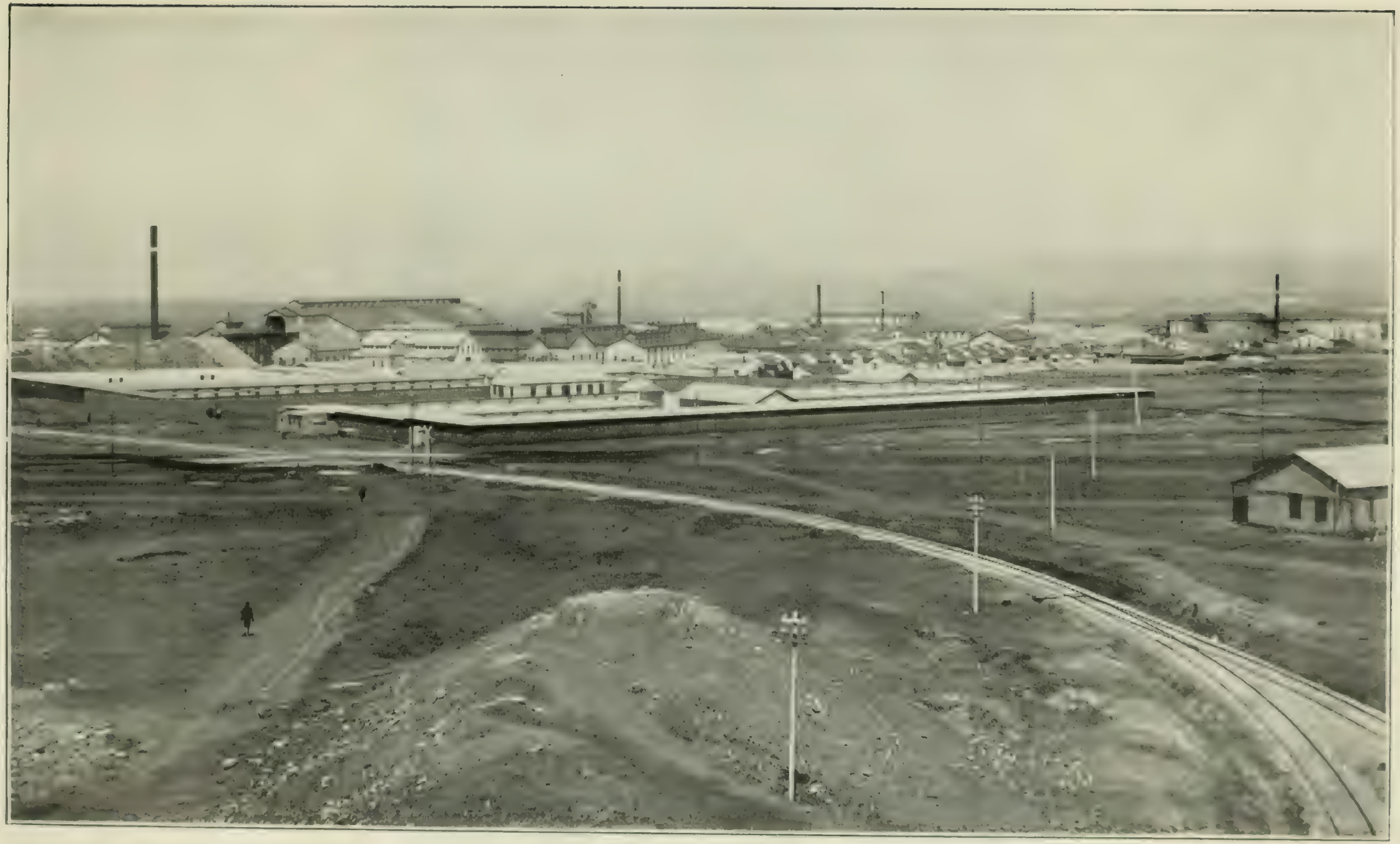


JOHANNESBURG IN THE EARLY DAYS. FROM A PHOTOGRAPH TAKEN ABOUT TEN YEARS AGO.

By permission of the Art Photograph and General Publishing Co., London.



THE SIMMER AND JACK MINES, WITH THE WITWATERSRAND RANGE IN THE BACKGROUND the Atlantic and Indian oceans. Twelve years ago it was hardly more than "uninhabitable downs, where geographers placed elephants for want of towns."

Jealous of their hard-earned independence, and apprehensive of the result of the influx of population that would inevitably follow the discovery of gold, the Boer inhabitants had passed laws making it illegal to prospect for gold within the country. Not until 1868, when impelled by the dire financial straits of the government to take measures to replenish the exhausted exchequer, was a different policy adopted; and then a bonus was offered for the discovery of paying gold fields. The success of this expedient is well attested by the increase in revenue from £177,876 in 1885 to £4,886,000 in 1896.

COMMISSIONER STREET, JOHANNESBURG.

By permission of the Art Photograph and General Publishing Co., London.

As a result of this incentive, prospecting was actively carried on by the Uitlander class,* and alluvions and quartz veins were discovered in various parts of the Transvaal. It was not until 1885, however, that the gold-bearing conglomerate beds were discovered. At the end of that year a five stamp battery was erected, and in 1886 the farms in the vicinity of Johannesburg were proclaimed "public diggings." A rush for the new gold fields soon set in. The township of Johannesburg was laid out in the latter part of 1886, and the fabric of a great mining centre began, but under conditions most untoward, owing to the inaccessibility of the nearest railway termini, about 293 and 366 miles distant. The fortunate discovery of coal fields in close proximity to the mines has contributed greatly to the successful development of the industry. This discovery was made almost immediately after that of the banket reefs.

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* Uitlanders means the outlanders,—those not born in the country.

In 1892 the main trunk-line from Cape Town was pushed forward from its then northern terminus to Johannesburg. The distance from Cape Town to Johannesburg by rail is 1,013 miles. In 1894 the road was completed from Delagoa Bay, a port in Portuguese territory on the south-east coast of Africa, to Johannesburg —a distance of 377 miles. The third road reached Johannesburg a year later, from Durban, a port in the British colony of Natal, distant 483 miles.

SIMMONDS STREET, IN FRONT OF THE STOCK EXCHANGE, JOHANNESBURG.
By permission of the Art Photograph and General Publishing Co., London.

From 23,000 ounces of gold in 1887, the annual out-put has risen to 3,000,000 ounces in 1897, giving the Transvaal the second place in the world's gold production. As I shall show later, there is no doubt that the present output of the country will rapidly increase ; and probably within a few years, notwithstanding the increased outputs of other countries, the Transvaal will rank first as a gold producer.

The town of Johannesburg may be taken as a good index of the wonderful expansion of the gold-mining industry of the district.

From a few huts in 1886, it has developed into a town unexcelled, if indeed equalled, in the imposing character of its buildings by any of the enterprising mining towns in western America. Indeed, Johannesburg has but little of the aspect of an American mining camp. In its general appearance it reminds an American more of Spokane or Salt Lake City. Its population in 1896 was 70,000 whites and about 250,000 blacks.

The scope of this article admits description of only the salient geological features of the auriferous deposits. The gold occurs in parallel beds of conglomerate interstratified with quartzites, sandstones, and schists of several lithological varieties. While some of these schists are of sedimentary origin, there is no doubt that, as suggested by Hatch, many are derived by mechanical and mineralogical metamorphism from basic igneous rocks—chiefly from diabases and diorites.[*]

THE RAND CLUB, JOHANNESBURG.
By permission of the Art Photograph and General Publishing Co., London.

Hatch, in his recently-issued geological map of the Southern Transvaal[†], giving the sequence of the South African strata, correlates the Witwatersrand beds with the "Table Mountain" sandstone occurring in the southern portion of the Cape Colony. The Table Mountain sandstone is in the lower half of what is called the

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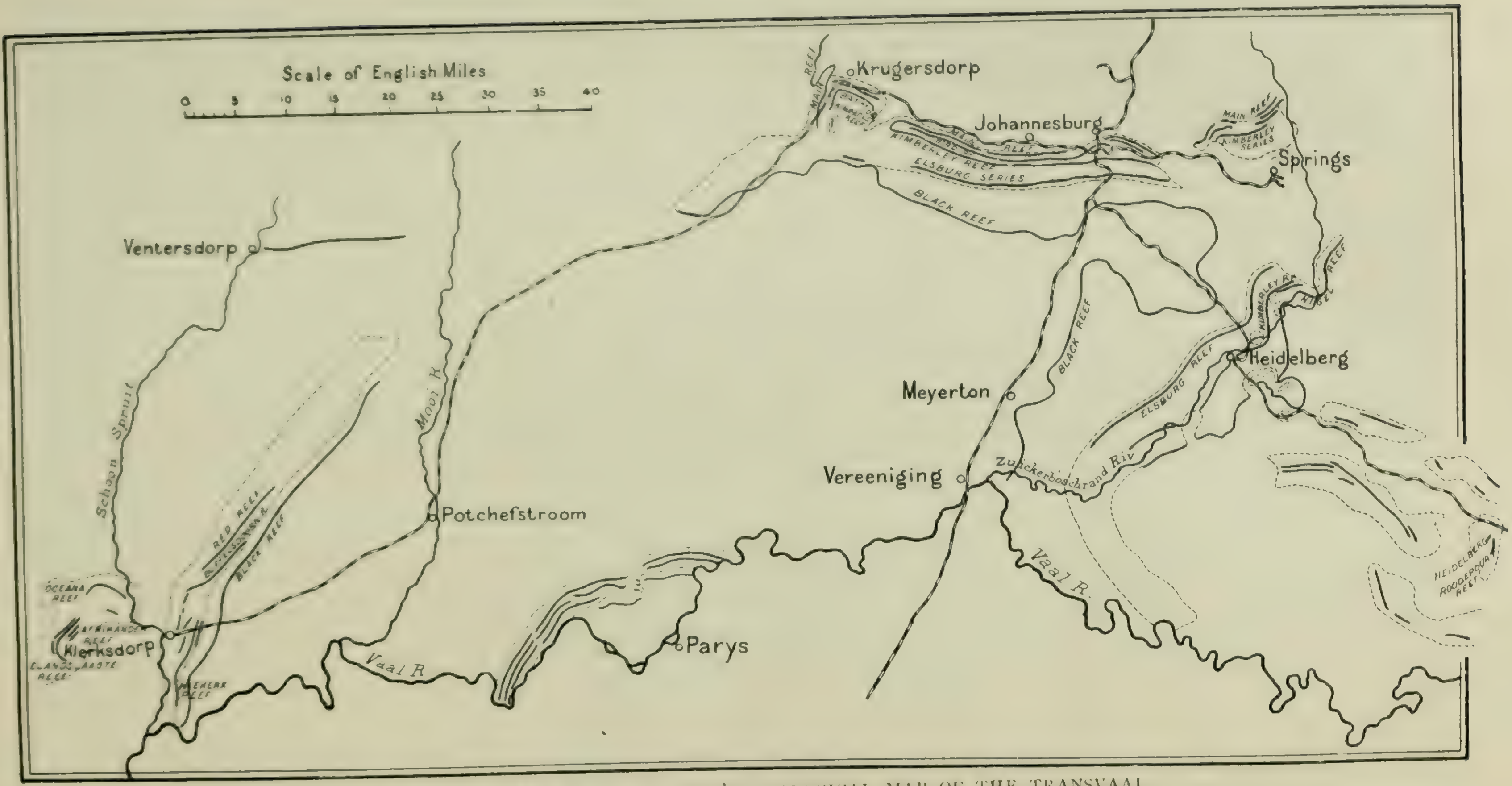
[*] For further details respecting the geology, the curious reader is referred to "The Gold Mines of the Rand," by Hatch and Chalmers, published by McMillan & Co., London.

[†] Published by E. Stanford, Cockspur Street, London.

A GENERAL VIEW OF A PART OF JOHANNESBURG AT THE PRESENT TIME.
By permission of the Art Photograph and General Publishing Co., London.



REDUCTION FROM F. H. HATCH'S GEOLOGICAL MAP OF THE TRANSVAAL.

Cape system, which has its probable European equivalent in the Paleozoic.

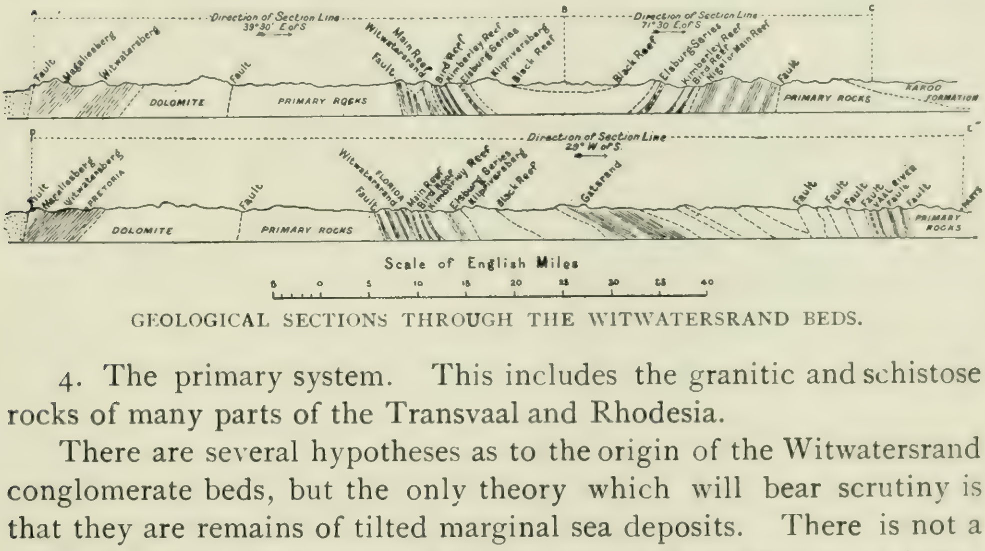
The main sub-divisions of South African stratigraphy, as given by Schenck and Green, are, in descending order:

1. Recent deposits.

2. The Karoo system, to which in its facies the Transvaal coal measures correspond, and which may be assigned to the lower Mesozoic of Europe.

According to Becker,* the coal-bearing beds of the Karoo system are Triassic, or possibly, in part, Permian. They are nearly horizontal, almost undisturbed, and conceal the older rocks over large tracts of country.

3. The Cape formation, the upper division of which includes the dolomite of the Transvaal and the auriferous conglomerate known as the Black Reef; the lower portion,—*i. e.*, Table Mountain Sandstone,—as stated before, includes the Witwatersrand conglomerate beds, and also the banket beds of Zululand and the Orange Free State.



GEOLOGICAL SECTIONS THROUGH THE WITWATERSRAND BEDS.

4. The primary system. This includes the granitic and schistose rocks of many parts of the Transvaal and Rhodesia.

There are several hypotheses as to the origin of the Witwatersrand conglomerate beds, but the only theory which will bear scrutiny is that they are remains of tilted marginal sea deposits. There is not a tittle of evidence in support of the theories of their fluviatal or lacustrine origin; on the contrary, these theories do not square with any of the observed phenomena.

There is no doubt that the conglomerate beds (banket reefs) were originally marginal sea deposits. In the process of the earth's evolution, through causes known to students of dynamical geology,—the approximate cause of which was undoubtedly the intrusion of a large mass of granitic rocks from the north,—the banket-bearing strata were folded into anticlines and synclines. Subsequent erosion has completely removed the anticline. The metamorphism of the arina-

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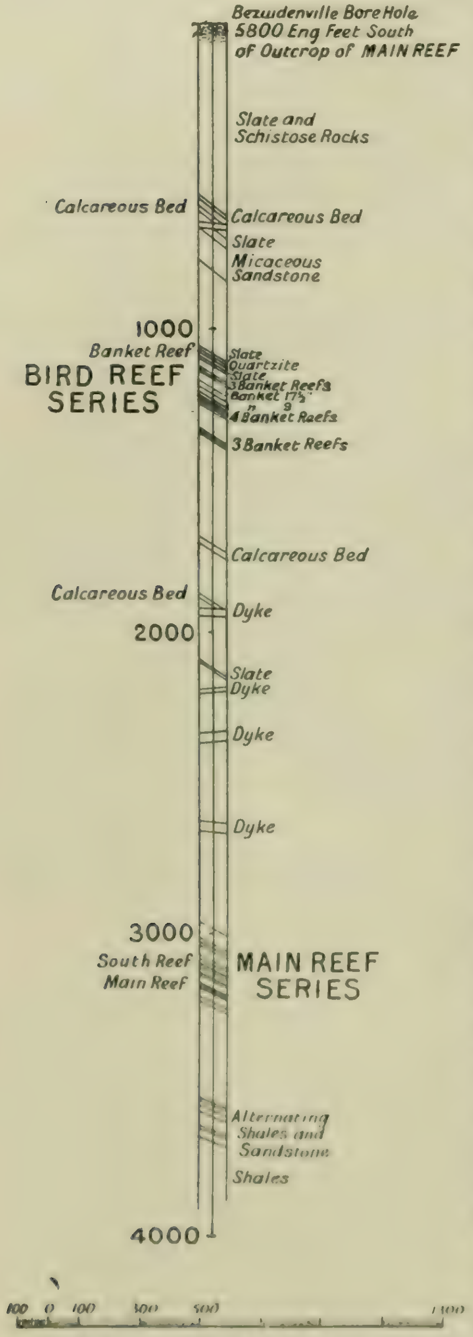
* Published by the United States geological survey. An important contribution.



THE BEZUIDENVILLE BORE HOLE.

ceous shore deposits into highly-indurated sandstones and quartzite accompanied the upheaval. The consensus of expert opinion certainly favours this theory. When it comes, however, to the question of the origin of the gold in the conglomerate, the best of doctors disagree. By those who maintained that the deposits in question are of fluviatal origin it was obviously asserted that the gold was detrital. Unfortunately for the composure of the minds of curious scientists, the fluviatal theory of the origin of the gravels has been found untenable. To-day the point is still controversial, but the scope of theorizing as to the genesis of the gold contents of the gravels is limited to three hypotheses.

The first is the precipitation theory, which has recently been advocated by M. De Launay,* and which is indeed, as Dr. Becker points out, an elaboration of a theory previously suggested by Mr. Penny. This theory maintains that the sea in which the banket was deposited was a saturated solution of gold and pyrite, and that the auriferous contents were deposited *pari passu* with the accumulation of the conglomerate pebbles. A valid objection to this theory is that the gold is confined to the strata of pebbles,—*i. e.*, the banket,—and does not occur in the intercalated sedimentary rocks. As Dr. Becker says, "one would expect to find the sands at least as much mingled with the auriferous precipitate as the banket," and, as he further states, the fundamental hypothesis of a sea highly charged with gold and pyrite seems extremely improbable; otherwise how is the intermit-

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* "Les Mines d'Or du Transvaal," published by Baudry & Cie., Paris.

THE DRAKENSBERG MOUNTAINS, ON THE BORDERS OF THE TRANSVAAL.

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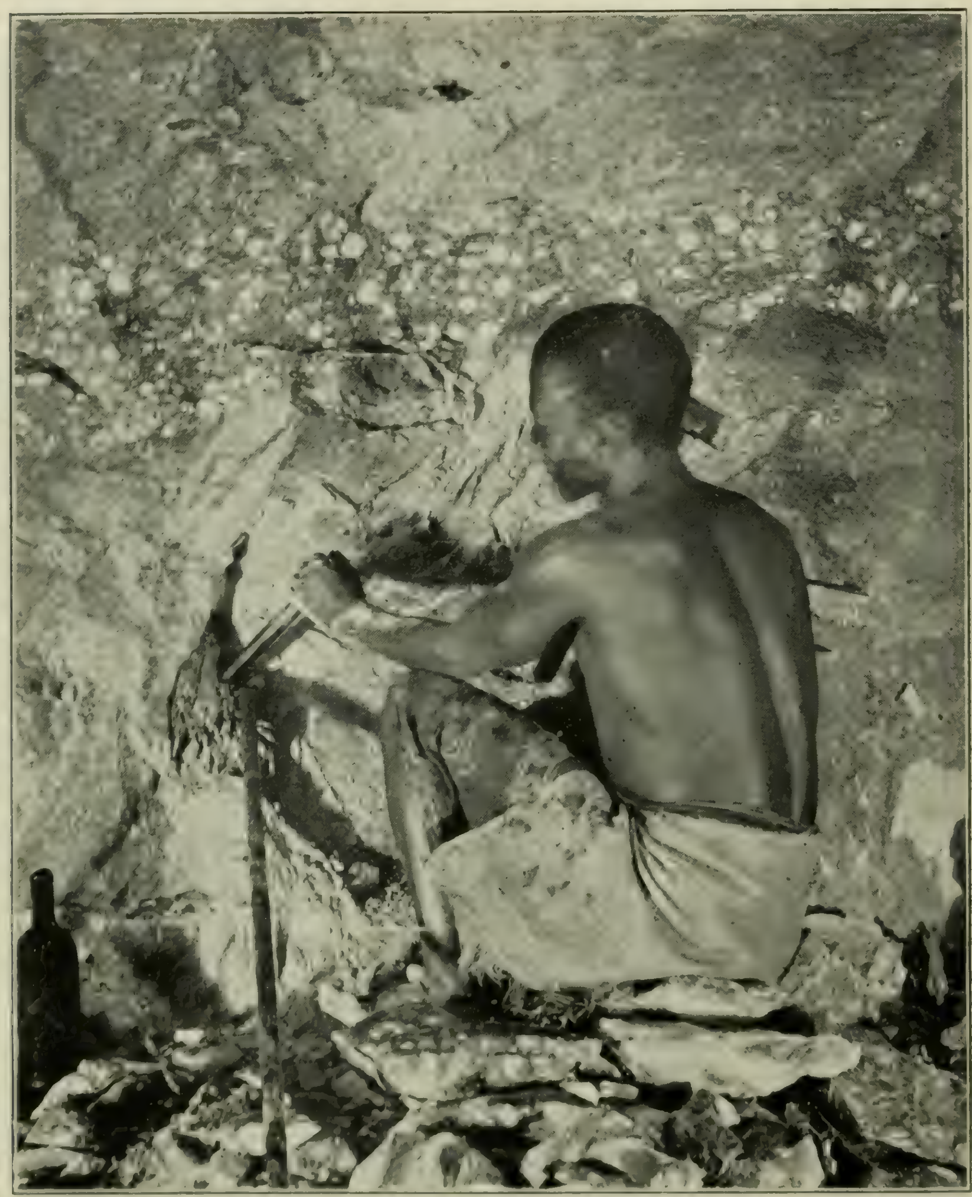


A HAMMER BOY IN THE STOPE.

The white pebbles above the Kafir miner's head indicate the banket reef.

tent action of the precipitation of the gold from its menstruum to be explained? Indeed, the fact of the auriferous character of the alternating banket beds and the non-auriferous character of the inter stratified sandstone and schists is, in itself, a refutation of this hypothesis.

The second theory has several able exponents, among whom Dr. Becker is most prominent. He calls it the "marine theory"; as its name implies, it refers the gold contents of the reef to placer origin, ascribing, however, the presence of crystallized gold to secondary action. There are several important facts which militate against it. According to this theory, the bulk of the gold should occur invariably upon the foot-wall, or lower portions at least, of the reefs. As a matter of fact, the lower are generally richer than the higher portions of the reef, but this is a phenomenon that applies to auriferous quartz veins as well. The larger pebbles generally occur nearer the foot-wall of the reefs, and the gold usually occurs, it is true, with the coarser pebble ; but in some mines the hanging-wall portions of the reef, notwithstanding the fact that the pebbles are smaller, contain the bulk of the gold. That the gold is associated with the large pebbles is proved by its absence in many of the bankets which contain larger pebbles than are found in the main-reef series. Indeed, in the main-reef series itself, the south reef, which contains the smaller pebbles, is almost invariably richer than the main-reef leader.

Another important objection to this theory is the occurrence of well-defined pay-shoots in the reefs. Dr. Becker admits the force of this objection, but questions the existence of such shoots of ore, and states that their occurrence would involve the assumption that there are two types of mineralised reefs,—*i. e.*, that the reefs where these ore-shoots are found were mineralised according to the third theory, which he describes as the impregnation theory, to which I shall presently refer.

There are most unquestionable evidences of the existence of such

NATIVE MINERS RETURNING FROM WORK.
By permission of the Art Photograph and General Publishing Co., London.

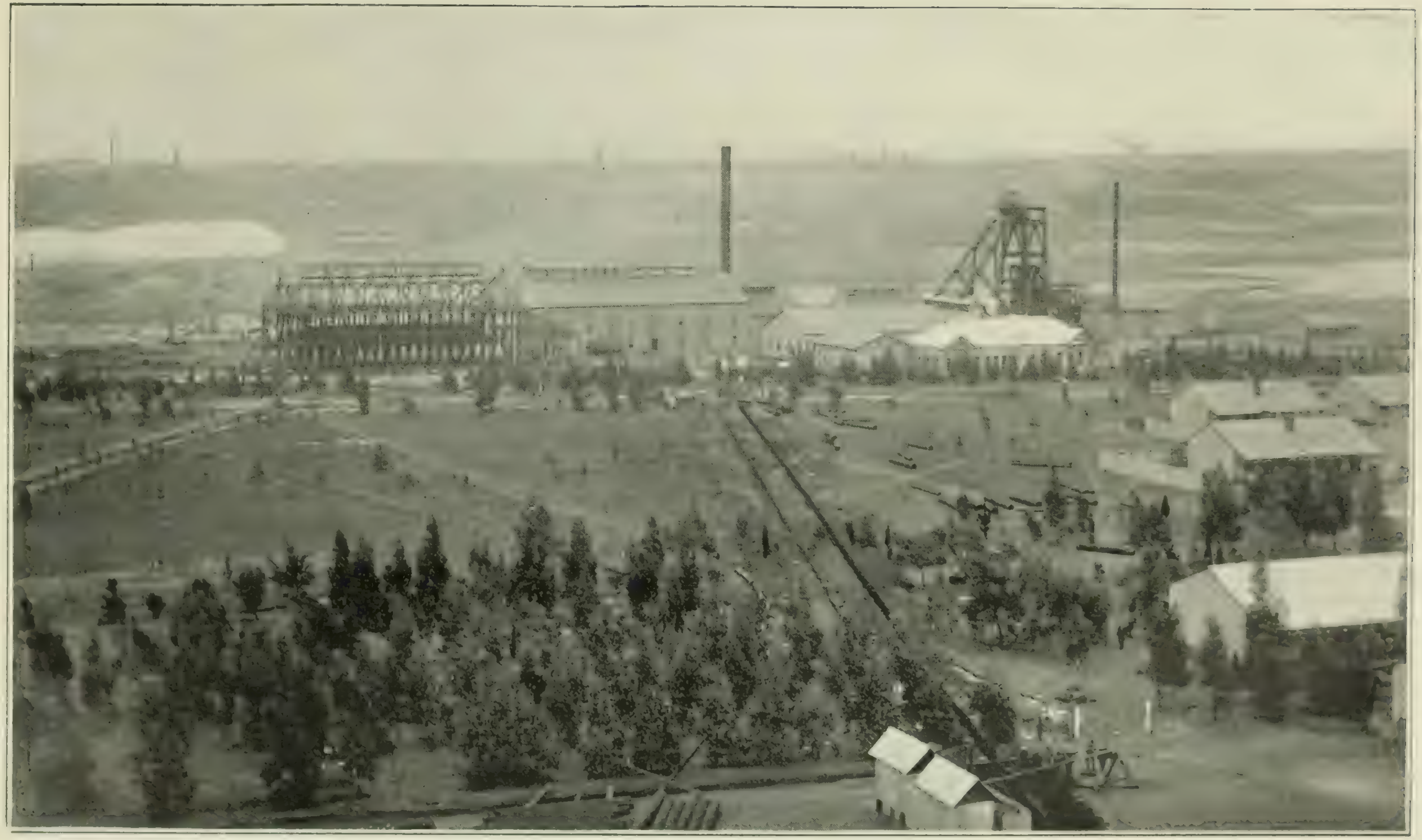
shoots of ore in the Nigel and Rietfontein mines. There are also evidences of shoots in other portions of the Rand, but I agree with Dr. Becker that in the great majority of cases the payable ore occurs in patches rather than in defined shoots. Indeed, it is sometimes difficult to distinguish between a pay-shoot and a mineralised patch. The elongated patches sometimes partake of the shape of ore shoots, but, on the other hand, pay-ore shoots in quartz veins frequently assume shapes identical with those of many of the so-called pay-ore patches of the Rand; the line of demarcation is, indeed, at times obscured.

The third theory, suggested by Messrs. Gardner F. Williams and J. S. Curtis, commends itself more favourably to the resident mining engineers of the district. This theory attributes the presence of gold and pyrite in the reefs to deposition from infiltrating solutions, as in the genesis of auriferous quartz veins.

According to this view, the mineralising solutions have come up along the planes of least resistance,—*i. e.*, the intersticial spaces of the banket reefs,—and the gold therefore has been deposited since the upheaval of the conglomerate beds.

Dr. Becker points out some irrelevant objections to this theory. The absence of fissures "in some localities where gold is nevertheless of good grade" is no stronger objection to this theory than to the theory of mineralising of quartz reefs by ascending solutions, where frequently there are long stretches of payable ore without any recognisable connection with the occurrence of such fissures. The gold-bearing solutions come up, as I have stated, along the planes of bedding of the banket, which undoubtedly have had connection with fissures, though generally more deep-seated than those to which Dr Becker refers. Dr. Becker further asserts "that there is no connection whatever between the tenure of the banket and the numerous dykes which traverse the formation." While the statement is generally true that there is as yet no ascertained connection between the richness of the banket and these dykes, there are some most important exceptions to Dr. Becker's assertion.

There are several notable examples of local enrichment of the reefs due to proximity of dykes. A very instructive illustration is in the Worcester mine, where there is an intrusive dyke, lying in the upper levels immediately above the main-reef leader. The hanging-wall portions of the leader, although the pebbles are smaller, are very much richer than the foot-wall portions, and maintain this character until in the lower levels, where the reef, having crossed the banket, forms its foot-wall. From this point the bulk of the gold contents of the reef is found on its footwall.



GENERAL VIEW OF THE ROBINSON DEEP-LEVEL MINE. TO THE NORTH, IN THE BACKGROUND, ARE THE OUTCROP MINES.

In the Ferreira mine there is an interesting occurrence of a dyke containing a considerable amount of visible gold. This dyke lies below the south reef, and is separated from it by several inches of fine quartz. The quartz itself is distinctly auriferous. That the dykes do at times greatly influence the gold tenure and the reefs is conclusively proved at the Buffelsdoorn mine, where indeed the payable portion of the reef is determined entirely by the proximity of the dyke.

The dykes of the Witwatersrand district are of several periods, as evidenced by the character of the faulting which they cause.

Associated with the banket beds, sometimes crossing and faulting

WITCH DOCTORS.

the formation, at other times imbedded with the banket, are numerous quartz veins. The quartz veins usually carry but little gold, but they have in places been found very rich, and have yielded considerable gold when crushed in the battery. As the result of the movement connected with the upheaval of the formation many of the quartz pebbles were cracked, but have been re-cemented by infiltrating quartz solutions. Upon the re-cemented cracks is frequently seen a fine deposit of gold. Sometimes the quartz pebbles have been found encrusted by minute crystals of quartz, which must have been deposited from infiltrating quartz solutions after the upheaval of the beds. The resemblance between the fineness of the gold of the bankets and that in the quartz reefs has in a few instances been proved, though investigations have been too limited to establish a general rule. There is, Dr. Becker to the contrary notwithstanding, a most important amount of visible gold in the unoxidized portions of the reefs.

In view of the foregoing facts, it seems reasonable to conclude, respecting the origin of the gold contents of the reefs, that a considerable portion has undoubtedly been derived from the marine theory, advocated by Dr. Becker. This is what one would expect, as the result of the concentration by natural processes of the eroded croppings of auriferous quartz reefs, as evidenced in the quartz pebbles of the banket bed ; but there is undoubtedly present a large amount of crystallised gold that can be best explained by the impregnation theory.

The bankets occupy the outcropping beds of a syncline ; erosion has obliterated the anticline, the limb of which was probably in the vicinity of the Magaliesburg Range, shown in the sectional drawings on page 741. In appearance, the outcropping banket reefs form roughly the rim of a basin, though there are many detached parts in the synclinal ore-deposits due to faulting, as well as more or less sinuosity in the lines of the outcropping reefs, owing to superficial inequalities whereby the symmetry of the basin-shape of the deposit is considerably marred ; for convenience of description, the term "basin" is applicable. The basin has approximately a width of about thirty miles. There are faulted portions lying at even more than thirty miles from the northern rim. The length of its longer axis is about one hundred miles. Conformably with the shape of the basin, the reefs dip towards a common centre ; that is, along the northern edge the reefs dip southward, while upon the southern edge they have a reverse dip, and the reefs upon the western edge and those upon the eastern edges of the basin dip east and west respectively.

In their upper horizons the reefs assume a high angle, frequently more than fifty degrees from the horizon, as the result of tilting, but, when followed in depth, they show a tendency to flatten; probably, at a vertical depth of 2,000 feet below the surface, the angle is rarely more than thirty degrees.

There are several parallel series of reefs within the syncline, at varying distances from one another, but exploitation has been chiefly confined to what is called the main reef series. This series occupies the outer, and therefore stratigraphically the lowest, rim of the basin, though what is known as the Rietfontein reefs, occurring to the east and to the west of Johannesburg, seems to be a still lower series. In the vicinity of Johannesburg this series seems to be wanting. There has been no extensive work upon this reef, with the exception of one mine.

There has been, however, considerable remunerative mining upon another banket series, locally known as the "Black Reef" series. This series lies unconformably above the main-reef series, and, as previously stated, belongs to the upper Cape system. The main-reef series comprises several beds, which have been fairly well correlated along the most developed portions of the Rand,—*i.e.*, to the east and west of Johannesburg, a distance of probably forty miles. No definite nomenclature attaches to these reefs throughout this distance, and it is doubtful if all the bankets are continuously persistent, though analogous reefs occur. Along the central section of the Rand, in the vicinity of Johannesburg, the reefs of the main-reef series in their ascending order are the main reef, the main reef leader, and the south reef. The main reef is by far the largest of the series, frequently as much as fifteen feet in thickness, but it is of low grade, and generally not capable of profitable working under present economic conditions. Immediately overlying the main reef, at distances varying from a few inches to several feet, is the main-reef leader, varying from a few inches to two feet in width. Separated from the main-reef leader by from thirty to two hundred feet of quartzite is the south reef, of about the same width as that of the leader. These two reefs in the portion of the Rand under description constitute the workable ore bodies, and are in value from a few pennyweights up to many ounces per ton.

The banket derives its name from its resemblance to the Dutch confection "banket" (almond rock). It consists almost exclusively of grounded or elipsoidal quartz pebbles, varying in size from that of small marbles to that of hens' eggs. Much larger and much smaller pebbles likewise occur. The cementing material is chiefly siliceous, the silica probably being derived from solutions similar to, if not indeed identical with, the infiltrating solutions by which the mineralisation of the bankets is supposed by many engineers to have been effected. The cementing material is also formed in part of pyrite, which is converted by oxidation to the sesqui-oxide of iron, imparting the well-known reddish and brownish colour to the reefs in the upper horizons. The gold occurs free, and also in the auriferous pyrite, which is almost exclusively iron pyrite. Most of the gold occurs in finely-divided crystallized form, usually invisible to the naked eye, though what is known as "visible gold," or "nuggets" analogous to the specimen rock known to our American quartz miners, is also frequently found. Under the microscope some of the gold contents is shown by its water-worn edges to be of detrital origin.

In a subsequent paper I shall discuss the probable gold contents of the reefs, the approximate life of the district, the mining laws under which operations are carried on, and other general considerations which seem worthy of discussion at this time.

These articles will serve as introductory to a series of articles by Messrs. Webb, Yeatman, and Holms, on the mining, milling, and cyanid practice of the Witwatersrand district.*

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* These gentlemen are prominent members of the engineering staff of the Consolidated Gold Fields of South Africa, of which company Mr. John Hays Hammond is consulting engineer.—EDITOR.

THE POSSIBILITIES AND LIMITATIONS OF ELECTRIC TRACTION.

By Frank J. Sprague.

II. THE MULTIPLE-UNIT SYSTEM APPLIED TO TRUNK RAILWAY OPERATION.

THE first division of this paper, which appeared in THE ENGINEERING MAGAZINE for January, discussed chiefly the application of the system of individual car equipment to rapid-transit or suburban service. It remains to consider the extension of the same principle to the service of the main line.

Taking up now this larger problem,—not larger in the matter of power or engineering accomplishment, but rather in that of extent,—its discussion has generally recognized but two electrical facts, namely, that a motor, and consequently a locomotive, could be built of suitable size, power, and reliability, and that sufficient energy could be transmitted to operate it ; and there has been too often the assumption that centralization means an immense saving in cost of motive power, and that the existence of a water power means supply *ad libitum*, free of cost. Capacity of motors and cost of power have generally been the only problems considered.

New elements have now entered into the discussion. One is the accomplished fact that any number of motors, or electric locomotives, may be intelligently and reliably operated from any selected point on a train. But there are other and serious matters to consider, and these may be briefly stated as the operation of effective signal and automatic braking systems, and power storage or equalization.

While many systems of signalling have been proposed,—some by the writer and many by others,—careful tests must be made in order to warrant implicit reliance on them. The most promising method seems to be the use of devices introduced into the connecting arms from a main to a sectional working conductor. It is not, however, my purpose to discuss these systems here, but it is safe to assume that practical systems can be devised, although the selection is a much simpler matter when considering a new line than when the change or abandonment of existing equipments is involved.

Of electrically operated brakes, while there are some which are amply powerful, and while motors are themselves available for this purpose, either by returning current to the line in slowing down, or by closing of circuits through resistances, or, in addition, through magnetic brake coils, none are finalities, and the only existing electrically-operated automatic brake system is that in which a motor supplies air to an automatic air brake. This, for the fullest development of electric traction, is not entirely free from objection, and, if electricity be used to propel, light, and heat a train, it is logical to expect that it will also be used to stop it, and just as effectively. Hence I venture to prophesy (and that prophecy outlines something of my own plans) the not distant advent of an electro-mechanical, automatic brake; and it may be pointed out that on some of the hardest of electric service—that of elevators—various combinations of electric and mechanical brakes are already used.

We are now finally confronted by the condition of supply and its source. Railway service, street and suburban particularly, is analogous to elevator service. It is marked by frequent starts and stops, sharp variations, and quick accelerations and retardations. The load on a generating equipment is varied and severe. This has recently led me to endorse the use of a suitable storage battery under definite restrictions for isolated plants supplying lights and elevators, and to recommend its use in central-station practice, particularly in distributed centres. The result is apparently most encouraging.

It is unfortunate that for many years the progress of the storage battery was practically stopped by vexatious litigation, and by an entire misconception of one of its highest fields of usefulness, which is, in general, service as a regulator or for short-period heavy discharge, rather than for long-time storage and slow discharge. This field of the battery is now more clearly seen, and, for the purpose of these remarks, batteries may divided into storage and regulating types, the latter being constructed with special reference to quick charge and very rapid discharge, with reasonable storage capacity. The improvements made recently have greatly improved the battery, increased its storage capacity, and immensely increased its safe discharge rate. These results, which will be undoubtedly bettered, and with reduced cost, will have a far greater influence on the application of electricity to heavy traction than all the water power in the world for many years, and until the cost of fuel is radically increased. In fact, except in cases where water power is easily available, and cost of fuel prohibitory, the function of water-supply is limited.

In this connection it is interesting to note that in Buffalo, where coal is a dollar per ton, the experience of the Buffalo Street Railway Company has not been favorable to the direct use of water power, though Niagara is but twenty-four miles away. At the current rates, and under the conditions of operation, coal proved the cheaper, and water will make a favorable showing only when the variations are taken care of by a storage battery so that the cost charge, which is made on the basis of maximum power supplied, may represent more actual energy delivered in twenty-four hours. I think it likely that the application of a storage battery to the steam equipment would show very favorable results. Having come to somewhat similar conclusions about the storage battery, I some months ago made a definite proposal to put on the Manhattan Road of New York a number of individualized cars with the multiple-unit control system, and for the supply through a live third rail I planned to use storage batteries placed at two or more stations, supplied by rotary converters operated from a multiple-phase transmission plant or by one or more steam engines and dynamos of moderate capacity locally situated.

Referring again for a moment to the subject of suburban service, radical as the proposal for the Illinois Central seems, I have no hesitation in endorsing them, as entirely within the range of practical accomplishment.

Given then effective motors, single and multiple control, accepted systems of signalling and automatic braking, efficient transmission and storage regulation of power from whatever source, how far is a trunk line warranted in adopting electricity? Just here it is well to point out some of the conditions which govern trunk-line operation, and the fact that all trunk lines are not alike.

The conditions of passenger traffic on such lines—that is, where long journeys are made—are absolutely different from those on suburban or other short lines, where railway travel is but an incident of daily life, and where the arrival and departure of trains at certain hours, and frequency of units, are absolutely essential to meet the requirements of the suburban resident. If one wishes to go from New York to Chicago, or from London to Edinburg, it matters little that train departures are at two- or three-hour intervals, because the journey is a thing which may be considered by itself. In these days of luxury, it would practically be impossible to concentrate in one or two cars all the advantages which a limited train to-day presents, and no possible traffic which can be safely predicted (especially in view of the fact that between important points competing lines exist) warrants more than a certain number of cars per day in transit. For long-distance travel, then, the present effort of trunk-line managers is concentrated in a comparatively few well-equipped trains, affording all the comforts that a passenger can ask for.

And it is well understood that in freight-handling the constant effort of every progressive railway management is toward concentration of loads by increasing the capacity of cars, the size of locomotives, and the length of trains, and the further equipment of such trains with brakes permitting of their being handled in large units at high speed.

Again, on a large number of trunk roads, passenger service and freight service are performed on the same tracks, rarely on more than two (there being one notable exception in the United States), and very often on a single track, as, for example, the larger portion of the distance between Chicago and New Orleans. So long as tracks do this double duty of freight and passenger service, it is absolutely necessary to concentrate both passenger and freight trains into large units, and to run them at comparatively infrequent intervals. It is safe to say that efficient railway management in the handling of passenger and freight trains, the latter often representing the larger business, on many existing roads will accomplish more in earning a dividend than any saving which can possibly be effected by the introduction of electricity, no matter what the original source of power.

Much has been said and written upon long-distance, high-speed electric railways; but a line could not be built, say from New York to Chicago, devoted exclusively to passenger service, with existing possibilities of passenger traffic, and return an interest on the investment—no matter what the rate of speed determined upon, nor how attractive it could be made.

At all times, as an offset to any saving in transportation account and cost of power, there must be considered the increased investment. While fewer electric locomotives could safely do the work of a given number of steam locomotives, still, considering all classes of equipment, it may be safely assumed that the cost of the power equipment supplied to the rolling stock will be fully as much for any electric system as for steam. It follows that every dollar spent in central stations, whether for water-power or steam engines, turbines, dynamos, or converters, and whatever the system of distribution, is an excess charge against the electric railway, and is warranted only when the saving in fuel, in transportation wages, and in depreciation, or the increase of business, will insure a material dividend on the increase of investment.

Of course, all roads have a very large amount of what may be called *dead* investment, represented in road-bed, tracks, signal systems, etc., as distinguished from rolling stock, which may be called a *live* investment, and which forms so important a part of the total that no one would think, for example, of building a road to be operated ever so cheaply so far as locomotive power and cost of rolling stock were concerned, if a two-train-per-week schedule were to be adopted, such as that of the Sunset Limited from Chicago to San Francisco.

The distributing section of any electric system may be classed as "dead investment," and must necessarily be large, but it is safe to say that even that necessary to convert an active steam line (such as the New York division of the Pennsylvania Railroad), into an electric system, would be far more profitable, and more certain of earning a good dividend, than that which would be required for constructing a competing steam road running through the same territory.

Increase of traffic requirements, and the spur of competition, are continually making necessary improvements of a character favorable to change of motive power.

Rock ballast, duplication of trackage, abolition of grade-crossings, and practical insurance of private right of way, with the making of intrusion a penal offence, will go far to insure electric traction. All these improvements, however, being the result of increased traffic demands, indicate that the laws which tend to perfection of present equipment also lead to the gradual adoption of electricity.

Without going into any special argument, it may be pointed out that electric motors may be used to assist trains over heavy grades even on a steam section, and that many electric feeders to steam lines will be built, especially where engineering difficulties are pronounced.

Much general prediction has been indulged in on this subject of steam main lines and electric feeders, but, considering the variation in density of traffic on different sections of a trunk-line system, I expect to see in some instances the reversal of this idea, so that the outlying and infrequently-served portions of a system may be steam, while the main section, where train movements are concentrated, may be electric, such sections corresponding to what is now covered by an "engine run."

I may then briefly sum up conclusions:

Motors or motor combinations can be built which will surpass in power, and in tractive and speed capacities, any locomotive which it is practicable to construct and operate.

All necessary power can be efficiently and effectively transmitted for reasonable distances electrically.

Frequency of service is ordinarily a *sine qua non* in determining the adoption of an electric system. Whatever the size of units, if the number between terminal stations be sufficiently large, electricity can be used; if the number be few and infrequent, electricity should not be used.

All street, elevated, and underground railroads and suburban systems, many branch steam lines, special lines built to meet particular conditions, and lines where steam power can be gotten only at high cost, but where water is available within reasonable distance, should now be operated electrically.

The multiple-unit control—that is, the individualizing of cars, and the control of them from any selected point—is the preferable method of equipment, on any of the above classes of road, whenever train-combinations are at any time advisable.

Locomotives and locomotive cars should be built with multiple motors, power-controlled, and individualized. They should be arranged so that two or more can be operated at will, or automatically, from either end, and from any situation in a train.

Automatic electric brakes, having the general functions of automatic air brakes, will be used on electric systems and also on many steam trains.

The storage battery, so modified as to have a fairly quick charge rate and a very rapid discharge rate, with moderate storage capacity, will come into use as an equalizer, and is of far more importance than existing water powers in determining for the present, and so long as fuel is available at low rates, the application of electricity on a railroad.

The presence of water power "within a few hundred miles more or less" is not of itself sufficient to justify a trunk line in adopting electricity, for, contrary to the usual assumption that water power costs nothing, the interest on the additional investment, and the capitalized risks of possible delays or interruption, will often more than offset the entire cost of coal.

So long as the service of an existing first class steam road is well supplied by a locomotive system with comparatively long trains and infrequent service, and so long as there are but few units between terminal points the road is not justified in adopting electricity.

Electric motors will often be used on special feeders to steam lines, and as boosters on heavy grades. With regard to main-line traffic, on such trunk-line systems as may gradually adopt electricity in part, it will be used on such portions corresponding to an "engine run," as the density of traffic will justify, and it will be preceded by such other improvements in road-bed, abolition of grade-crossings, etc., as are necessary and as would be adopted even if steam were retained.

Finally, every road must be considered by itself in connection with the conditions surrounding its operation, and the business to be developed, and with regard to the probable economies to be effected by a change in motive power as well as by a change in the system of handling trains.

THE ECONOMY AND EFFICIENCY OF THE LARGE GAS ENGINE.

By Dugald Clerk.

IN a former article I reviewed the earlier experiments in the design of the gas engine, and traced the development of types up to the largest units of the present day. It remains to consider the leading difficulties in the problems which now present themselves, and the prospect for their early solution.

There are two classes of difficulties which have hitherto prevented a more extended use of large gas engines. The first class consists of gas-engine difficulties *per se*, and the second of gas-producer difficulties. In all compression explosion gas engines a charge of gas and air is compressed in a cylinder, and then ignited, and the piston moves out under the pressure produced. The exhaust valve is then opened, and the return stroke discharges the exhaust gases. The piston, however, does not enter the compression space, and in many gas engines a certain proportion of burned gases is thus left in it. This does not seriously affect a small engine, because the cooling surface of the cylinder is so great in relation to the heat evolved by the combustion that, by the time the exhaust stroke is completed, and before a fresh charge of gas and air is admitted to the cylinder, the gases have cooled down to a temperature sufficiently low to avoid ignition of the entering charge. If, however, the engine be of comparatively large dimensions, it often happens that the exhaust gases have not been sufficiently cooled during the exhaust stroke, and consequently these gases retain lingering flame. On the admission stroke of the engine the gas and air admitted to the cylinder come in contact with this flame, and the charge ignites while entering. This, of course, produces an ignition down the admission pipe, and causes the engine to lose an explosion. In the scavenging engines of the Messrs. Crossley a certain volume of cold air is sent through the cylinder to discharge the exhaust-products and fill the cylinder with cold, pure air. This scavenging process has long been advocated by me. I was the first, I believe, to use it in gas engines. This was in 1881. The Otto cycle engine did not adopt any scavenging process until about 1886. Several engines of that type, notably the Griffin engine, adopted a scavenging stroke to clear out the exhaust-products; but adoption of this precaution was not frequent until about 1894, when the Messrs Crossley introduced Mr. Atkinson's method of scavenging by utilising the velocity of the exhaust in the exhaust pipe, for the purpose of producing a current through the cylinder.

Messrs. Wells Bros. had adopted scavenging in some of their Otto cycle engines before that date, and the engine illustrated last month has a scavenging cylinder taking in an air charge, and discharging it through the exhaust space in each cylinder alternately. The process of scavenging overcomes almost completely this difficulty of lingering flame, and consequent ignition of the entering charge; but, even with the scavenging, unless the engine be very carefully designed to avoid port spaces or any hollows not swept out by the air, the flame is still apt to linger, and to ignite the entering charge. It is not wonderful that this should be the case when one considers that the maximum temperature of the ordinary explosion in a compression-gas-engine cylinder is about 1,800° C., and that in most of these engines the complete revolution is accomplished in one-third of a second,—that is, the forward stroke, after explosion, lasts one-sixth of a second, and the return stroke, discharging the exhaust, lasts another sixth. It is rather remarkable under these circumstances, with so short a time allowed for cooling the explosive mixture, that the flame is burned out so completely as appears to be the case. In small engines it is found that the burning out is very complete. With these, even running at 400 revolutions, it is difficult to ignite on the charging stroke. In large gas engines, however, running at 180 revolutions, the sixth of a second elapsing between the beginning of the exhausting stroke and its termination is not sufficient to so cool down the large volume of the gases as to make the cylinders safe for the admission of another charge. Accordingly, the air charge greatly assists in so preparing the cylinder as to avoid firing while the charge enters.

In modern engines the cylinders and their compression spaces have been so designed as to expose the minimum surface for a given volume, and to expose it as little as possible in the shape of ports, passages, or narrow spaces.

The compression has also been raised in many gas engines to nearly 100 pounds per square inch before ignition. This increase in compression assists very greatly in avoiding back ignitions of the class described, by causing a greater conversion of heat into work during the expanding stroke, and a consequent lower terminal temperature of the gas in the cylinder just previous to the opening of the exhaust valve. In the best of the larger engines, at present, the terminal temperature generally exceeds 1,200° C. High pressure and scavenging have, however, got rid almost completely of untimely firing on the charging stroke in engines up to and including 200 i. h. p. The higher compression, however, has introduced another difficulty,—that is, a tendency in a large engine for the charge to ignite while on the compression stroke, before the piston has been thrust fully in. That is, a difficulty has been transferred from ignition of the charge as it enters to the premature ignition of the charge during compression. This is due to the considerable rise in temperature of the gases during compression, and to the heat added to those gases from the piston end while compressing. The temperature of the end surface of the piston of a large gas engine, while exposed to frequent explosions, is very considerable. Even with a well-designed piston, it cannot be far short of a low red heat, approaching 700° C. Considering that the temperature of gas compressed to 100 pounds above atmosphere is about 250° C., it is not surprising that occasionally the charge fires during compression by the heat added from the piston. Again, the formation of a very small carbon deposit on the surface of the compression-space would, under these circumstances, also tend to produce ignition during compression. This difficulty is met in the large engine by the use of gas-and-air mixtures not too strong in gas. If too much gas be present, these premature ignitions during compression are very apt to occur, especially in engines where any projecting metal pieces are found in the interior of the cylinder or compression-space It is necessary, in order to avoid this difficulty, to have no bolts or separate projecting pieces from the heads of valves, lest these may heat up and help to produce an ignition apart from the ordinary tube igniter.

These are the leading difficulties with large gas engines so far as the combustion in the cylinder and irregular ignition are concerned. One other difficulty lies in the necessity of providing an ample margin of strength in the engine-frame, crank, connecting rod, and other parts, to stand a pressure considerably higher than the ordinary working pressure. This precaution is necessary because sometimes, from wrong adjustments in the proportions of gas and air admitted, the engine cylinder may be charged with a mixture easily combustible and this may occur after several missed ignitions, so that the cylinder gets completely filled with a mixture which is cold and as rich as possible in gas. Such a mixture may easily produce an explosive pressure thirty per cent. in excess of the usual maximum pressure, and this has to be provided for. In a steam engine no such excess pressures have to be considered.

Then again, the fact of the engine getting only one impulse for every two revolutions necessarily increases the dimensions and weight of the engine. Further, the difficulty of governing gas engines by varying the impulses, instead of cutting them out, has not yet been overcome. The engines now run very steadily, but not so steadily as do the best steam engines.

In consequence of all these difficulties inherent in the gas engine itself, notwithstanding its great thermo-dynamic advantage over the steam engine, it has not, for large powers, taken the place which it should.

The other class of difficulty is that due to the gas producers now in use. Until very recently, the Dowson gas producer was the only producer practically on the market, and to operate it to best advantage anthracite coal is required, costing about 18 shillings per ton. Notwithstanding, then, that the gas engine consumed about 1 pound of anthracite against 2, or perhaps 2½, pounds of coal in a good steam engine of 200 h. p., the coal bill for the steam engine did not amount to more than the coal bill for the gas engine, because the steam-engine boilers would often use engine slack at about 9 shillings per ton, and sometimes even less. The Dowson producers now employed use coke as well as anthracite, but there are many difficulties with coke which do not yet appear to have been thoroughly thrashed out. The only producer making gas fit for use in the gas engine, and using common engine slack, is the Mond producer, and that, in my opinion, is much too cumbrous to be used to any considerable extent. The Mond producer is excellent where a complete plant is set up for the manufacture of gas and the recovery of ammonia, but it is very expensive, and suitable, so far, only for very large installations.

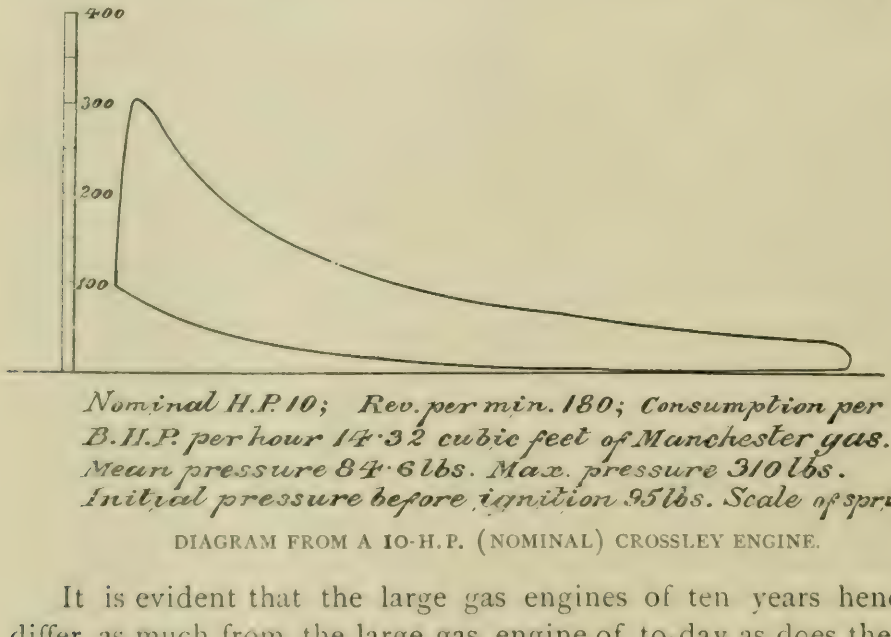
One great obstacle to its rapid development, apart from the engine itself, undoubtedly lies in the producer, and, until a cheap and easily-operated producer is manufactured, using common engine slack, and producing gas having, say, 80 per cent. of the heating value of the coal used, in a form suitable for a gas engine, it cannot be hoped that very rapid advance will be made.

There is thus ample scope for the engineer on the gas engine. For large powers it is still open to great improvement in itself, and the production of a cheap and economical producer using common coal would lead to an immediate and large extension and increase of competition with the steam engine.

Engineers are now at work overcoming these difficulties, and the line of action is well understood. Compressions are increasing very much, and better results are being obtained with high compressions. Even in small gas engines great advances are still being made in economy of fuel.

The figure on the next page is interesting. It is a diagram from one of the latest of the Crossley engines of 10 h. p. (nominal), showing a mean pressure of 84.6 pounds, an i. h. p. of 24½, a brake h. p. of 22.2, at 180 revolutions per minute, and a Manchester-gas consumption of 14.32 cubic feet per brake h. p. per hour. To my knowledge, this is the lowest gas consumption yet obtained for a given power, and, when this improvement is applied to the large engine, without doubt it will be possible to get a brake h. p. on 12 cubic feet of gas,—an actual efficiency of more than 30 per cent. of the whole heat given to the engine in the form of gas.

Although I have pointed out the defects of large gas engines, and the difficulties encountered up to the present stage, I have done so, not to discourage, but to assist, engineers.



Nominal H.P. 10; Rev. per min. 180; Consumption per B.H.P. per hour 14·32 cubic feet of Manchester gas. Mean pressure 84·6 lbs. Max. pressure 310 lbs. Initial pressure before ignition 95 lbs. Scale of spring $\frac{1}{180}$

DIAGRAM FROM A 10-H.P. (NOMINAL) CROSSLEY ENGINE.

It is evident that the large gas engines of ten years hence will differ as much from the large gas engine of to-day as does the latter from the engine of 1886 or 1887. There can be little doubt that, in ten years, gas engines of 1,000 h. p. will be as common as engines of 100 h. p. are now.

The problem is a most interesting one, both from a commercial and a scientific point of view; but, before gas engines can be applied on ship-board, it will be necessary to greatly improve their construction, governing, and operation. When they are so applied, the great advantage will be that vessels will consume, for the power developed, less than one-half of the fuel at present required. A large gas engine on board a vessel, so far as economy is concerned, could easily be run with half a pound of coal per i. h. p. hour.

SHIP-BUILDING AS A PRODUCTIVE INDUSTRY IN GREAT BRITAIN.

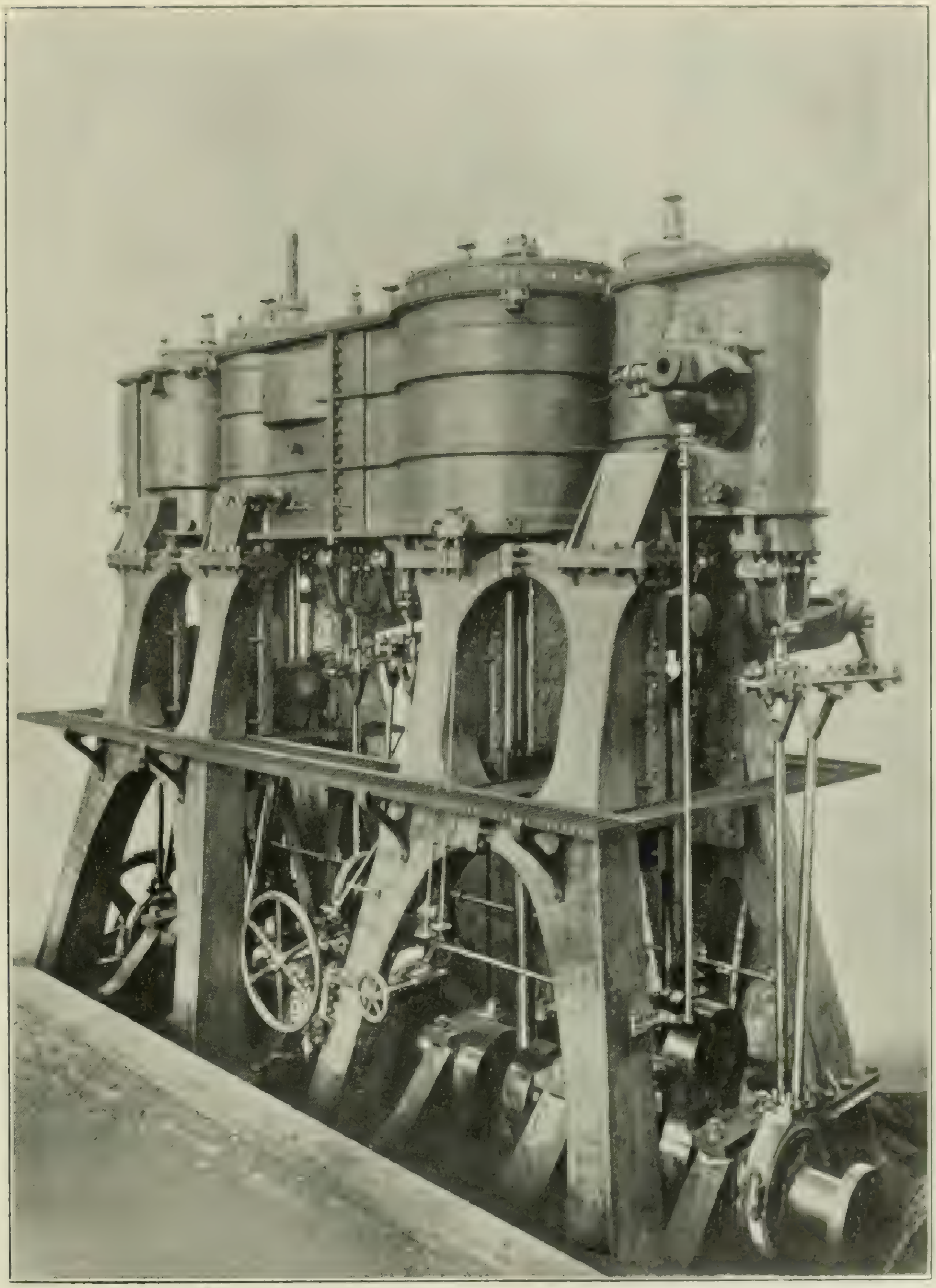
By James McKechnie.

III.—THE DECLINE OF SAIL AND EVOLUTION OF STEAMSHIP TYPES IN THE CHIEF DISTRICTS.

"IT'S only a Geordie." Thus disparagingly do the Clyde people often speak still of the north-east coast ship. It is only natural, for their rivalry increases: but the north-east-coast builders have the satisfaction of knowing that this jealousy is but the reward of some measure of success. Thus, when London was in the front rank,—ere yet the men's exorbitant demands brought ruin,—the pretensions of the Clyde builders were regarded with something of contemptuous fear. But, now as then, there is no reason why all perfection should be confined to any geographical division of Britain, or indeed to any country. There is exactly the same number of firms producing ocean-going steamers on the Clyde as on the north-east coast from Blyth to Whitby. The Clyde firms have produced an average of 345,000 tons during the past seven years, the north east builders 582,000 tons. Both districts are close by the iron and coal field; so also is Barrow; and Belfast and Hull have the advantage of easy railway or steamship communication. Of the other ports, excepting Birkenhead, it may be said that they build only an occasional ship. London depends mostly upon naval or repair work.

The ship-building industry is not so long established on the north-east coast as on the Clyde. This partly accounts for the superiority, or assumed superiority, of their ships of "quality." Sir Charles Palmer, who has long held a prominent position in the industry, built his first iron ship in 1852,—the collier John Bowes, I think,—and for some time the trade was confined to vessels carrying Northumberland coal to the London market. So long as the building of these paid, the firms were not disposed to compete with the Clyde in the production of passenger steamers which involved speed problems. West-of-Scotland merchants were early associated in commercial pursuits in the United States and across the Spanish main; and this fact, combined with their situation close by the Atlantic, also accounts in some way for their priority in the building of high-speed passenger lines. Thus most of the ships built ten years ago on the Tyne, Tees, and the other rivers in that part of England might almost be said to have been without form or comeliness. The aim was to build a vessel which would carry the maximum of cargo, coal, or ore; it was the fault of the physical laws, if such a receptacle was necessarily square-ended. Now a fair proportion, although not so great a percentage as on the Clyde, consists of passenger steamers of moderate speed. Still the high-speed steamer is exceptional, if we exclude warships. The Palmer Co., Wigham, Richardson & Co., Swan & Hunter, and one or two others have turned out ships which, for elegance and finish, are, as they themselves are pleased to claim, equal to those of the Clyde. I recall the Alphonso, built by Wigham, Richardson & Co. for Spain, and the Avon, for the Carron Company's service between the Thames and the Forth.

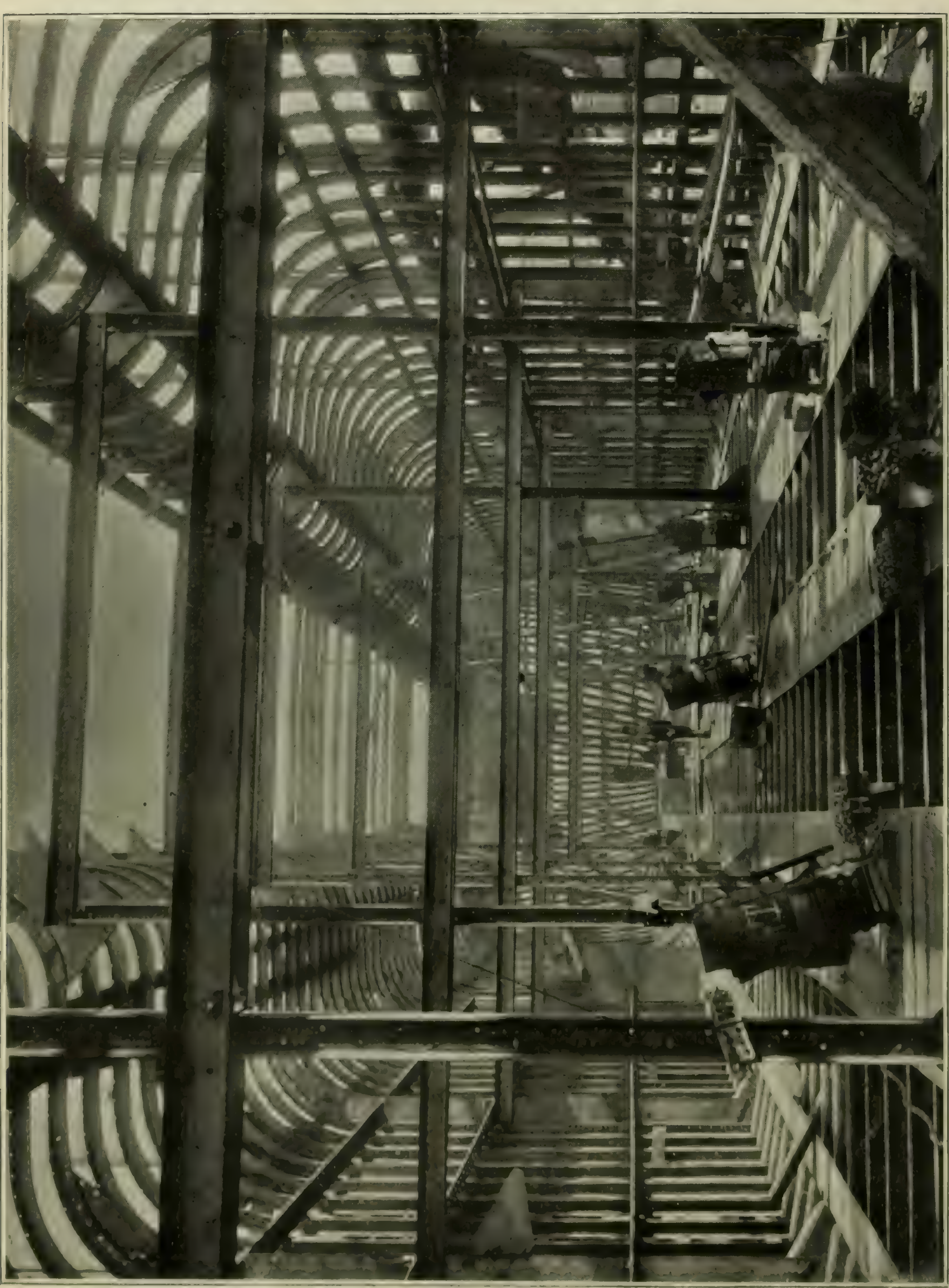
But, after all, an examination of Lloyd's List, which is the most comprehensive in the world, shows that for every twenty vessels built on the west coast—Clyde, Barrow, and Birkenhead—to steam 18½ knots, there is scarcely one north-east-coast ship. The great majority are of the purely tramp type, averaging 3,000 to 3,500 tons. Considerable ingenuity has been exercised in the design to secure the greatest advantage, but I am not going to enter into the mysteries or the controversies associated with all the types; Lloyd's have fourteen classes, and yet fail to satisfy demands. Mention, however, may be made of the Doxford turret type; a small fleet of vessels of that type have been constructed since it was introduced some five years ago. The photograph reproduced on page 766, with the cross-section, renders explanation unnecessary. The form of the weather deck improves the righting moment, but, as I am dealing chiefly with economic considerations, I will say simply that in most cases the hull capacity per net register ton is 25 to 33 per cent. greater than in the spar deck or well-deck steamer of corresponding displacement. The British Association for the Registry of Ships has made this a special class, in view of the great strength of the design: but Lloyd's refuses to do so, and herein perhaps may be discovered some support for the contention that monopoly does not encourage development. A Tees firm—Messrs. Ropner—has also introduced a departure which calls for reference here as an effort towards higher efficiency. It combines the principles of the well-deck, the partial awning deck, and the spar-deck type. There is no 'tween deck, and, instead of the spar-deck extending the full width of the ship, there is a central trunk running fore and aft in continuation of the engine coamings. This trunk is open for its full width to the hold for cargo, the top of it forming the working deck, on which are the winches, while the hatchway is also through it. This type is also illustrated by photograph and section. All firms are making a great effort towards greater fuel economy, and in this respect much has been done for British shipping supremacy.



FOUR-CRANK QUADRUPLE-EXPANSION ENGINES, YARROW, SCHLICK AND TWEEDY SYSTEM.

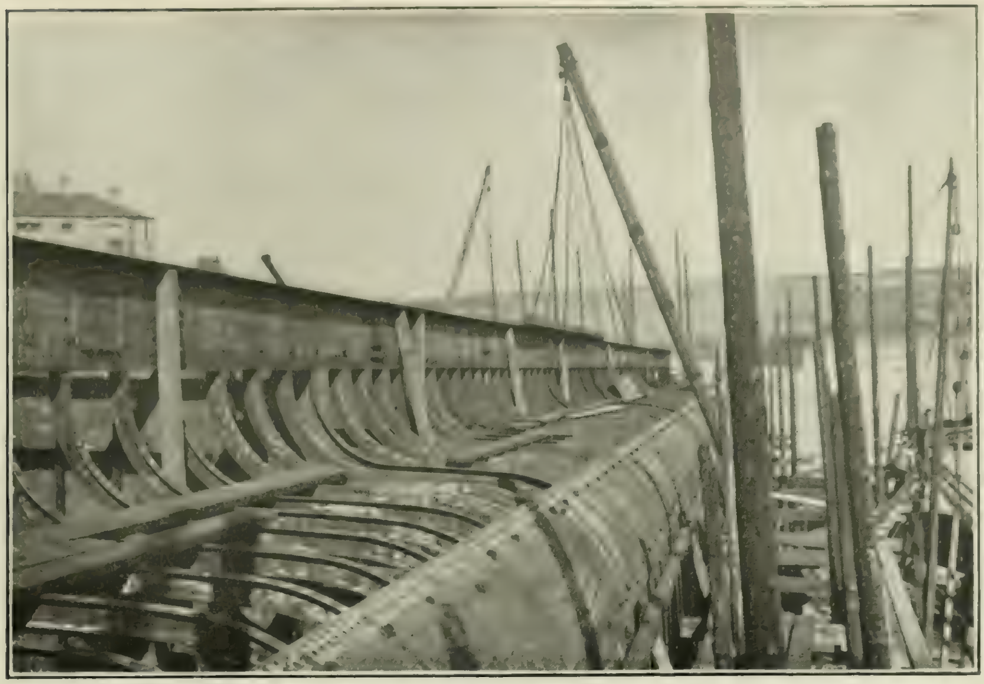
Constructed by Wigham, Richardson & Co., Newcastle-on-Tyne, builders of the "Avon."

Naturally the reader cognisant of what is being done in this direction will recall the quadruple-expansion engine, of Mr. Walter Brock, of Dumbarton, and Mr. J. Rankine, of Greenock, and Mr. T. Mudd's success with the Inchmona. Mr. D. B. Morison, of Hartlepool, has



FRAME OF A VESSEL OF THE DOXFORD TURRET TYPE, DURING CONSTRUCTION.

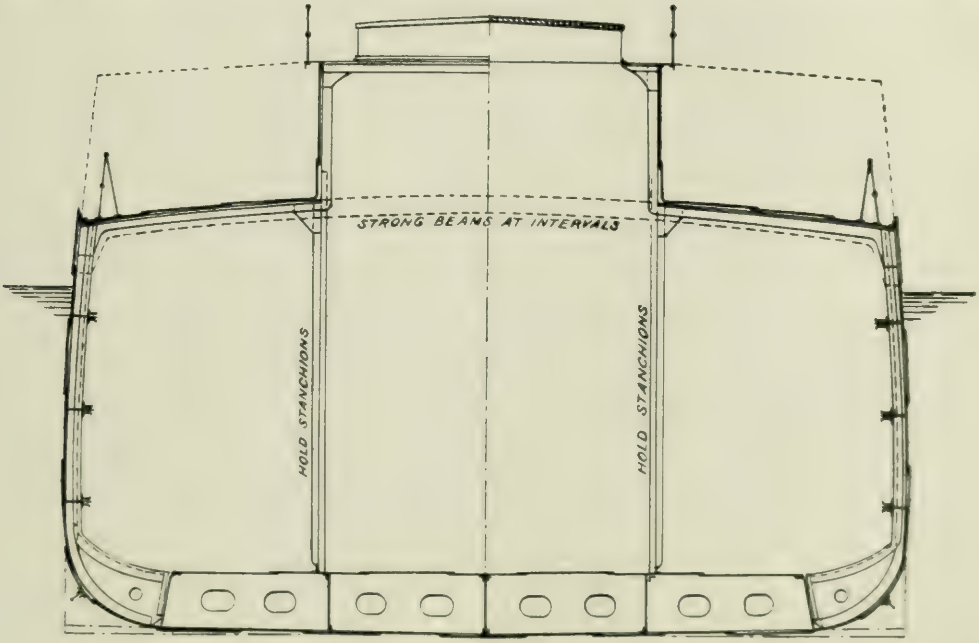
Built by Wm. Doxford & Sons, Ltd., Sunderland.



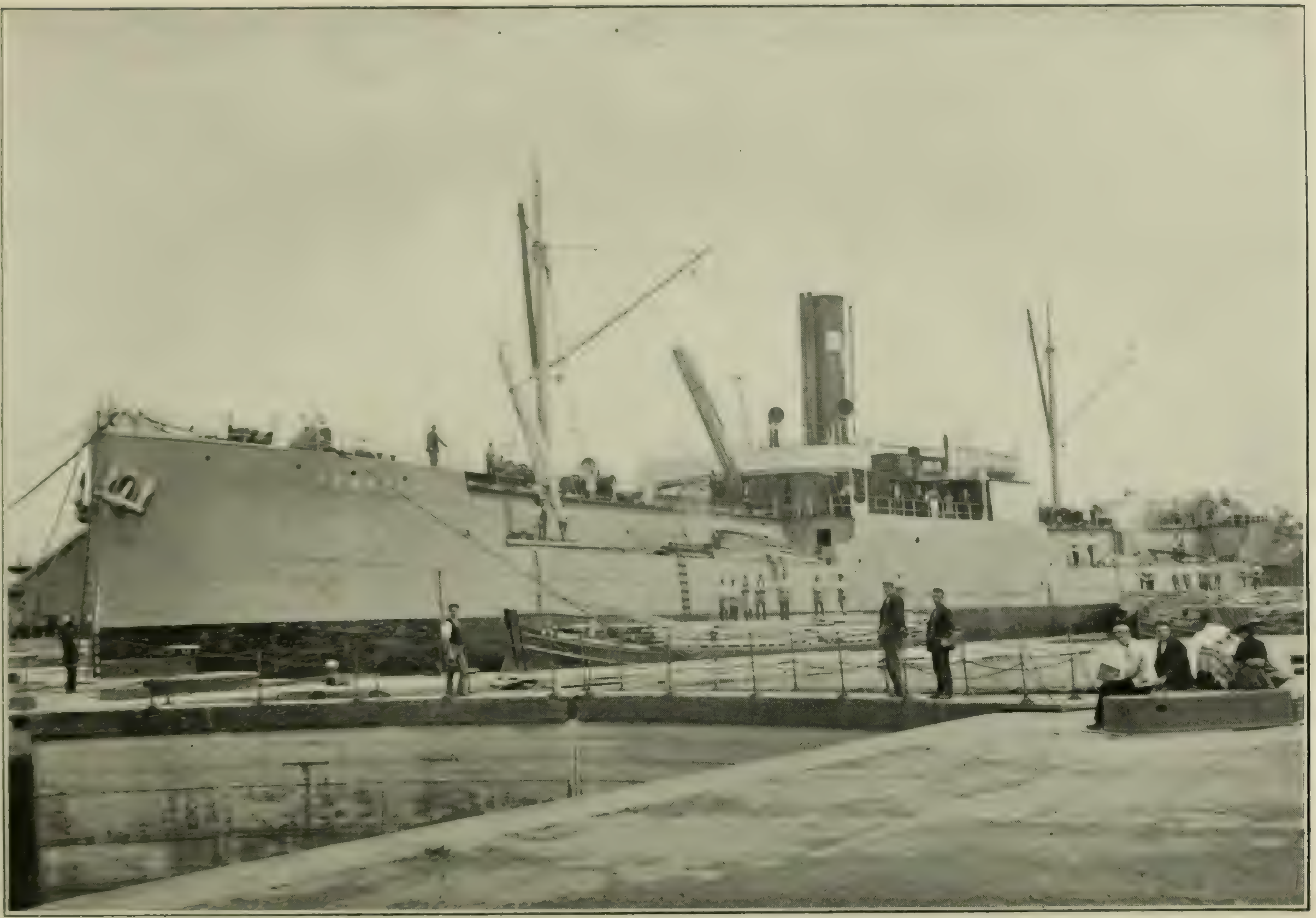
SHIP OF THE DOXFORD TURRET TYPE, IN COURSE OF BUILDING.

also done good service, and Mr. James Howden, of forced-draught fame, need scarcely be mentioned. Apart from engineers proper, Mr. James Weir stands to the front for his pumps and heaters.

It would be pleasant to dwell on these and other fruitful labours, but I briefly indicate them merely to show that the cargo steamer is

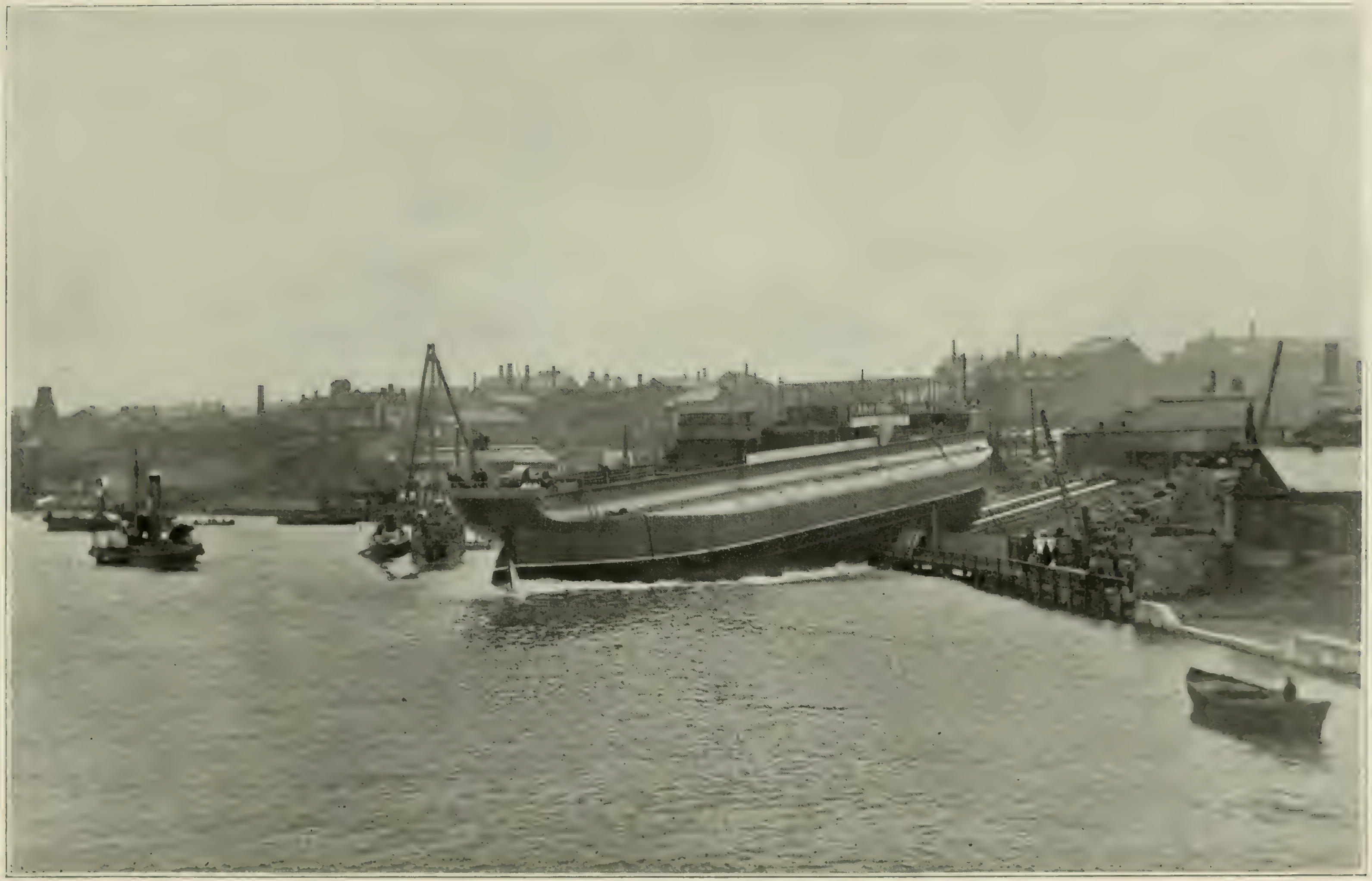


CROSS SECTION OF FIRST SHIP OF THE ROPNER TRUNK TYPE.



ROPNER TRUNK-TYPE STEAMER "TRUNKBY" AT THE WHARF.

Built by Ropner & Son, North Shore Shipbuilding Yard, Stockton-on-Tees.



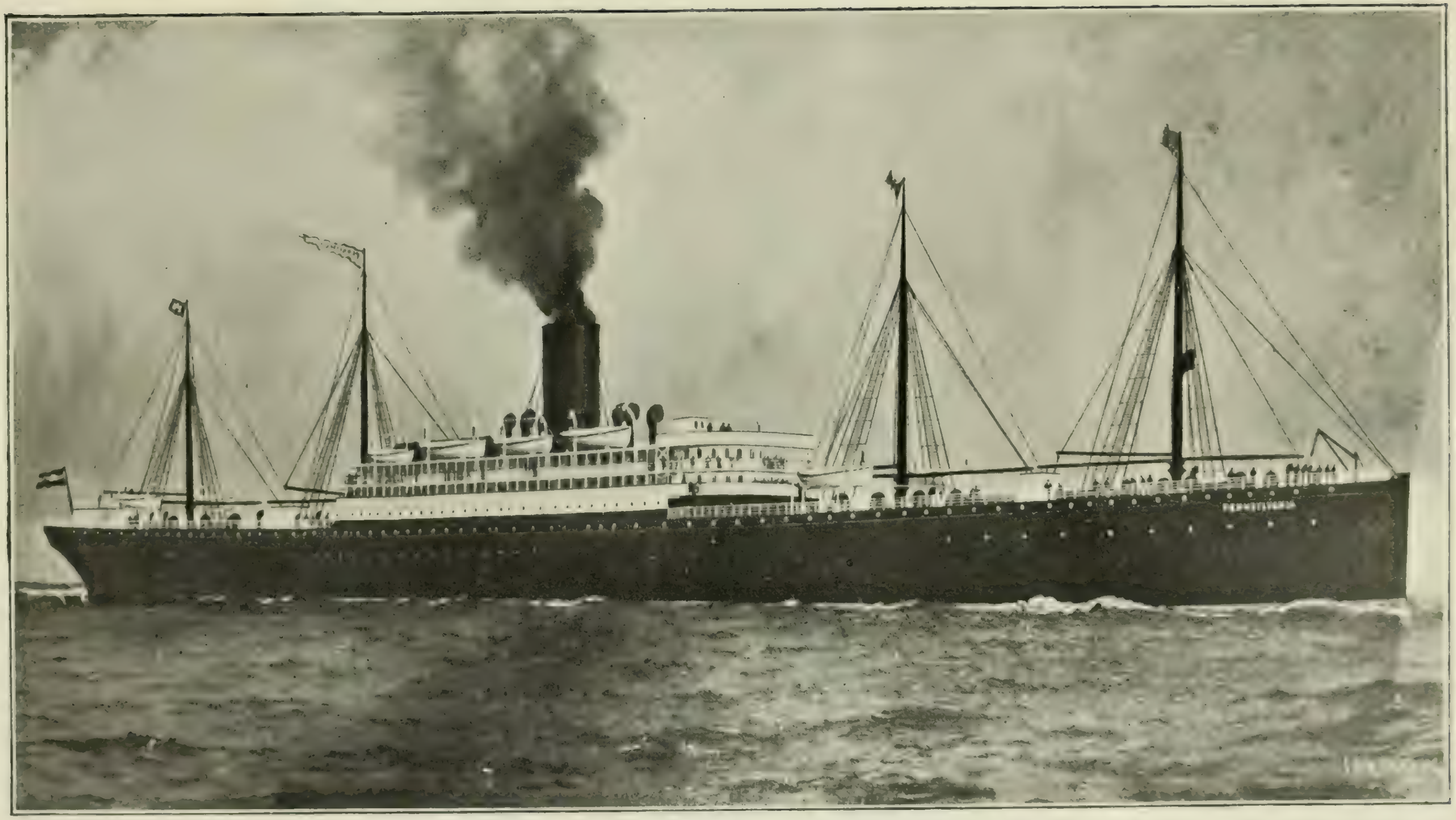
THE LAUNCH OF A TURRET SHIP AT THE PALLION YARD OF MESSRS. WM. DOXFORD & SONS, LTD., SUNDERLAND.

despised by no one. Even on the Clyde quite 80 per cent. of the ships built belong to this category. An examination of Lloyd's List again brings out the extent of their predominance in the world's fleet, the best measure being the small number of vessels capable of exceeding a speed of fifteen knots. In this way, too, one gets an idea of recent progress of such vessels. Britain has now 263, while three years ago she had only 205; in foreign fleets the number has increased from 99 to 133. Britain has 23 vessels whose speed exceeds twenty knots, and of these twelve are paddle-steamers engaged around the channel. Eight of the screw steamers are on the Atlantic, the others being in the channel service. Three years ago there were only ten in all. In foreign fleets the number of steamers with a speed of twenty knots or more is twelve,—only four more than there were three years ago. British vessels whose speed is between nineteen and twenty knots number 23,—an increase of five in three years. Seven of them are in the P. & O. fleet, in which great advance has been made, notwithstanding the long distances between coaling stations and the necessity for depending more on cargo for revenue than in the case of Atlantic liners. The following table may be interesting.

SPEEDS OF SHIPS.

	1894		1897	
	British	Foreign	British	Foreign
Vessels of 20 knots and more	10	8	23	12
" 19-20 knots	15	12	23	11
" 18½-19 "	4	3	8	4
" 18-18½ "	25	4	31	6
" 17½-18 "	9	16	8	14
" 17-17½ "	29	5	33	15
" 16½-17 "	17	4	16	8
" 16-16½ "	30	17	33	22
" 15½-15 "	12	6	11	13
" 15-15½ "	54	24	77	28
	205	99	263	133

When one recalls that in the British fleet there are, in all, 7,534 steamers, he recognises that the proportion of vessels able to steam at a speed of more than fifteen knots is very small,—about one in thirty,—while the total of 394 vessels of all nations steaming over fifteen knots, out of an aggregate of 14,183, shows clearly that the tramp predominates. Indeed, for every vessel that exceeds twelve knots there are probably twenty that jog along at a slower rate. The north-east-coast ports, however, share the honours, so far as the building of steamers of large carrying-capacity is concerned. Belfast has done

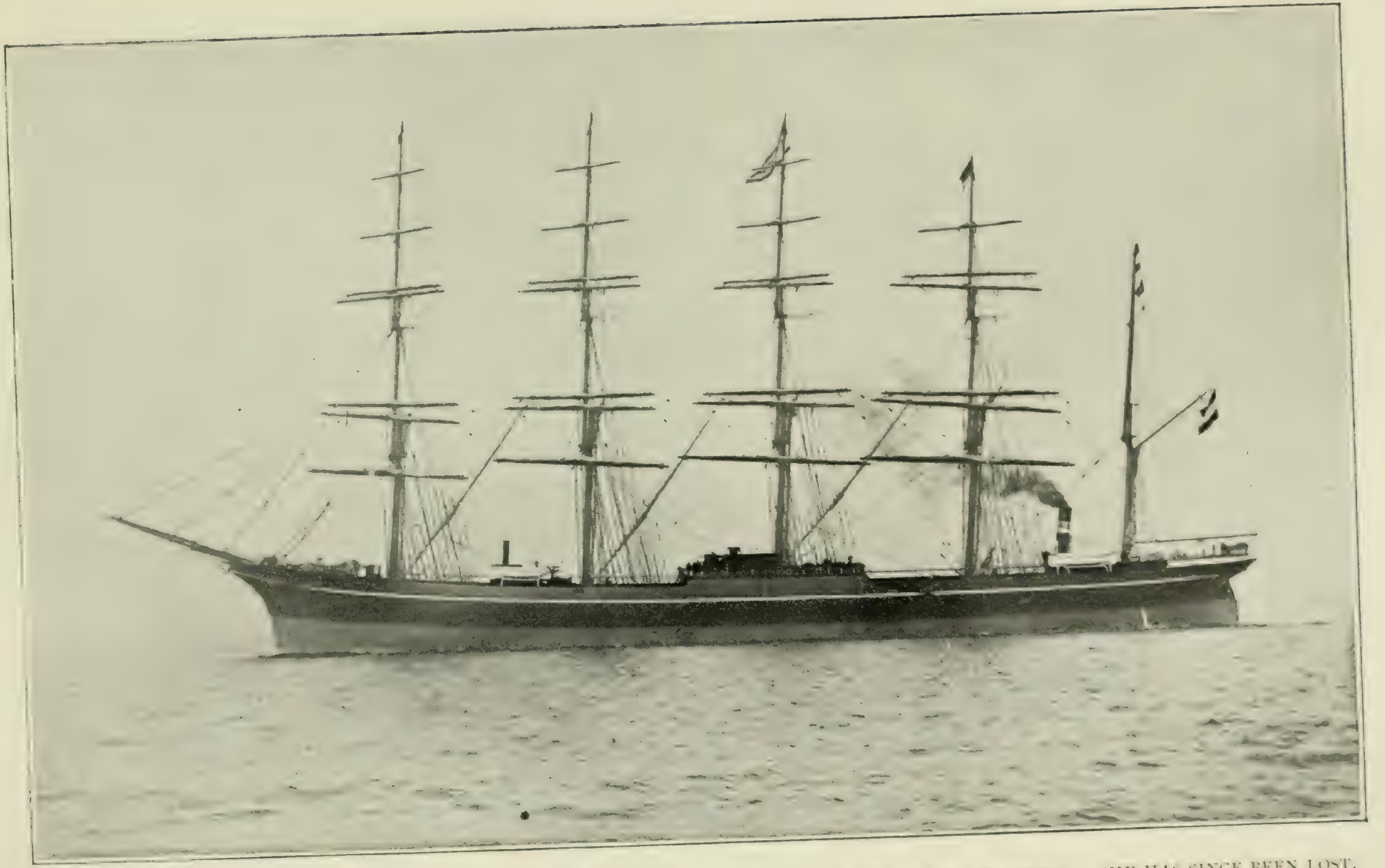


THE HAMBURG-AMERICAN LINE TWIN-SCREW MAIL STEAMER "PENNSYLVANIA."
585x62x40 feet. 23,400 tons displacement; 6000 i. h. p. Built by Harland & Wolff, Belfast.

more lately in this respect than any other of the ports. In each of recent years the two firms there—Messrs. Harland & Wolff, and Workman, Clark & Co.—have built fourteen or fifteen vessels of more than 5,000 tons, the largest, the Pennsylvania, having a carrying-capacity of 14,000 tons. In the British fleet there are now, in all, 215 vessels whose tonnage exceeds 5,000 tons; the United States have 5, France has 17, and Germany 23. Curiously enough, however, the United States beat Britain in the number of large sailing ships. They have nine that exceed 3,000 tons register: Britain has only six.

No sailing ships are built on the north-east coast; the exception only proves the rule. That is not a matter of to-day, when the sailing ship is generally in poor demand: it has obtained for many years. Indeed, one or two firms on the Clyde seem to provide all the vessels of this class for Britain, notably Russell & Co., of Port Glasgow, although the old firm of McMillan, of Dumbarton, has produced some beautiful craft. Two of Russell's ships were exceptionally large. The Somali, a four-master built for Messrs. G. M. Steeves & Co., Liverpool, is 330 feet long, 47 feet beam, and 29 feet deep. The gross tonnage was 3,537 tons, and the deadweight carrying-capacity 5,500 tons. This vessel was excelled in size by the Maria Rickmers, which was the property of the well-known Bremen firm, but has

THE LAUNCH OF THE "CYMRIC." THE VESSEL JUST BEING STOPPED.
Length, 599½ feet; gross tonnage, 12,340; 6500 h. p. Built by Harland & Wolff, Ltd., Belfast.



THE "MARIA RICKMERS," A TYPE OF LARGE SAILING SHIP. BUILT BY RUSSELL & CO., PORT GLASGOW. SHE HAS SINCE BEEN LOST.

Photograph by McLennan & Co., Greenock.

been lost. This vessel was 376 feet long, 48 feet beam, and 28 feet 4½ inches deep, her gross tonnage being 3,822 tons, and the dead-weight carrying-capacity 5,600 tons. But the largest sailing ship hitherto built is of German origin and ownership. She is named the Potosi, and carries 6,150 tons, her length being 426½ feet, beam 52 feet 6 inches, and depth 32 feet 9 inches. It is a question, however, whether so large ships are profitable. They are engaged mostly in the San Francisco, Australia, and nitrate trades. In the latter it is not infrequent for a ship to lie at one or other of the ports in the Pisagua range for three or five months, taking in cargoes in driblets from barges; so that the large ship is not profitable, unless, as in the case of the Potosi, she belongs to the nitrate merchant, who can hurry forward the process of loading, this being done in very many cases at the expense of other ships.

British owners have recognised the unprofitableness of the sailing ship, and, although Britain has not decreased the ratio of sail to total tonnage to the extent that some foreign nations have, because she is the carrier of the world and must meet all requirements, she has a great difference. At the beginning of the current decade the sailing ton-

THE STERN OF THE "CYMRIC" BEFORE LAUNCHING.

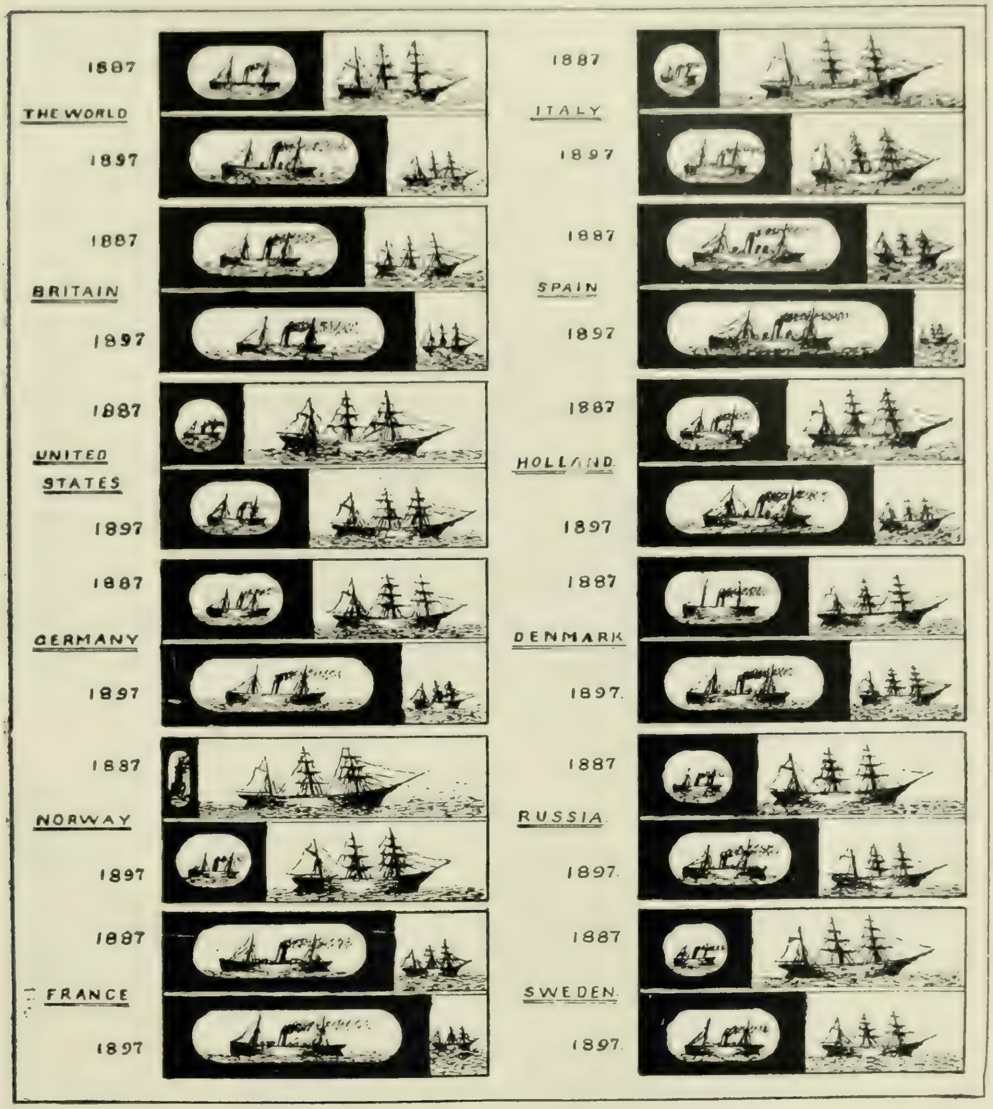


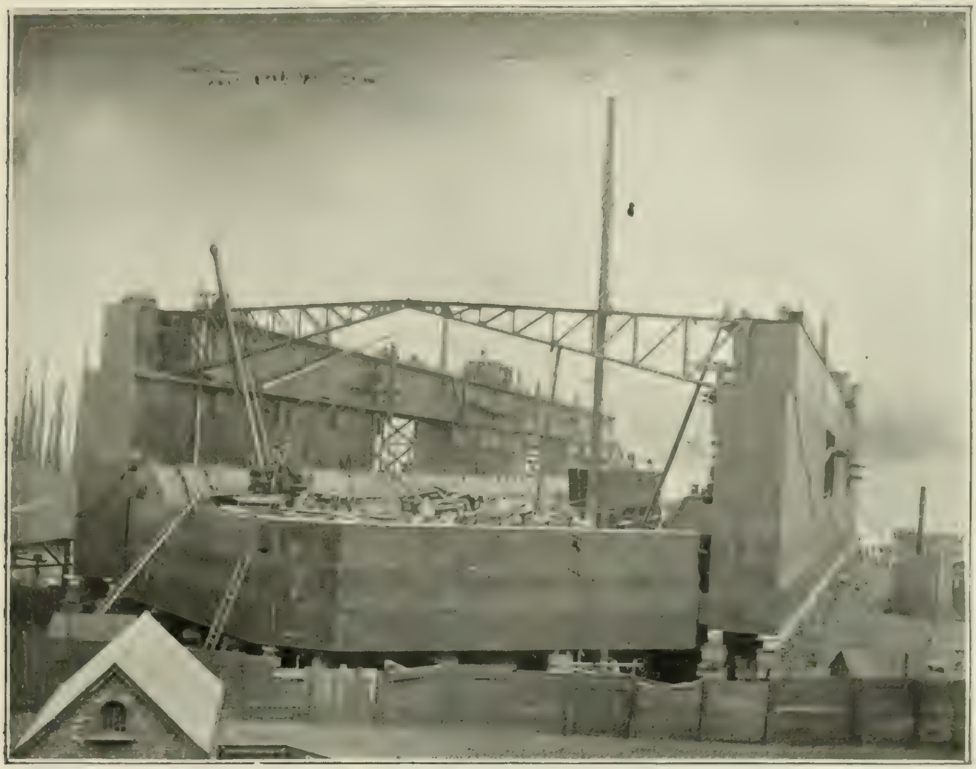
DIAGRAM SHOWING THE INCREASE OF STEAM AND DECREASE OF SAIL TONNAGE IN THE MARINE OF LEADING MARITIME NATIONS OF THE WORLD BETWEEN 1887 AND 1897.

The proportion of black area to white shows the ratio of steam to sail in the countries and for the years indicated in the margin.

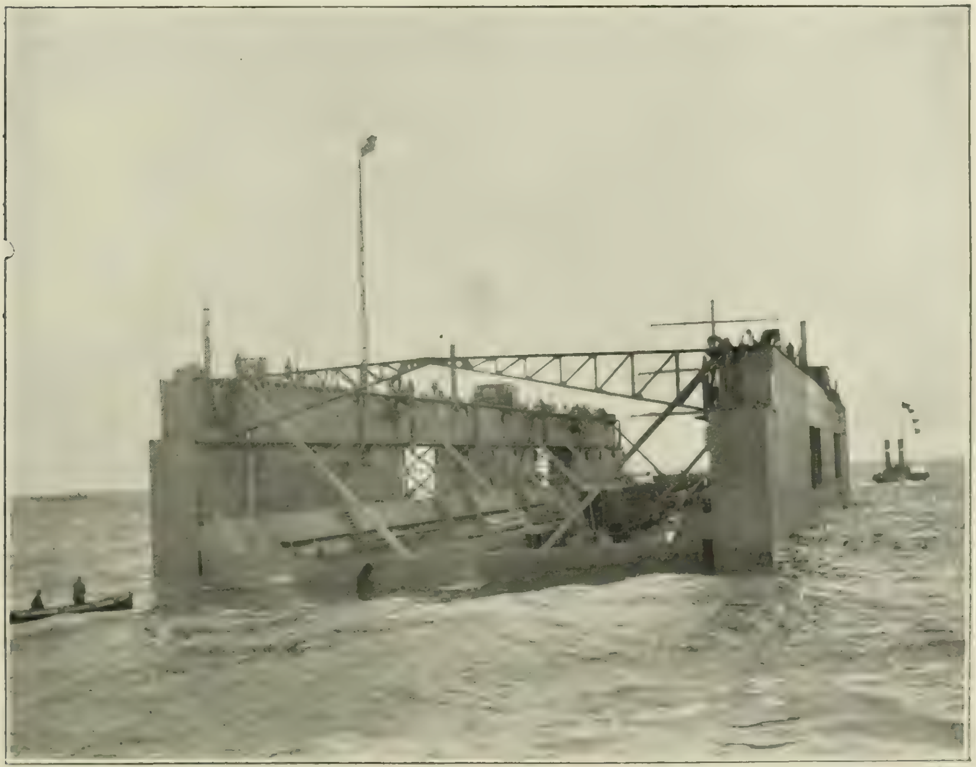
nage built averaged about one-fourth of the total merchant tonnage; it has dwindled to about a twentieth, although the contract price has decreased fifty or sixty per cent. In other words, the new British-built sailing tonnage in 1892 was 275,136 tons, while last year it was only 70,085 tons. Ten years ago Britain had 4,000,000 tons of sailing vessels in her fleet; now she has little more than 2,750,000 tons. The diagram on this page shows the difference in other fleets. It scarcely requires explanation. Each square represents the division of the fleet of a special country between steam and sail tonnage in 1887 and 1897. It would have confused the issue to have made the squares proportionate to the size of each fleet; as that has already been brought out, it is enough to indicate the change in the relative ratios of sail and steam ships. Thus we find that, of the world's fleet, 30.7 per cent. is sail, instead of 50 per cent. as it was ten years ago. This decrease is common to every country. In Britain it has decreased from 37.4 per cent. in 1887 to 21.3 per cent. in 1897; in the United States from 75 to 55 per cent.; in Germany from 54 to 25 per cent.; in France from 27.8 to 17.5 per cent.; and so on with the others, as shown on the diagram. France has the smallest ratio of sailing ships; Norway and the United States the largest.

Of course, the great factor in this change is the economy of steam-propulsion. Just as the compound engine made a great difference in the world's fleet, when British steamers displaced the sailing ships of the United States, so the triple expansion engine, with high-pressure steam, has involved a further curtailment of the sailing tonnage, and its practical disappearance seems only a matter of time. The north-east ports of England have been quick to recognise the change, although Belfast firms have profited most. The tendency is for low profits and a quick turnover, and thus one finds that the old firms still engaged in high-class work have to take a second place when mere tonnage-output is the standard. It is a misleading basis for comparison, for it is doubtful if the record-production, by a single firm, of 81,326 tons is equal to that of some of the firms returning 25,000 to 30,000 tons of warship and mercantile work with high-power machinery.

It is difficult to get accurate data of economic conditions in different districts; statisticians, as a rule, take a long time over their calculations, while the conditions are ever changing. Average earnings, too, are illusory, for, in one of the board of trade returns of recent years, it is shown that, whereas in London only seven per cent. of the workers are boys, in other districts the boys number twenty per cent. In Belfast, again, more unskilled labour is used; it is cheaper. But a return made lately does not show any material difference in wages of representative trades, except in the case of London. Thus pattern-makers got 36s. to 36s. 6d. per week on the Clyde, Barrow, and the north-east coast, 37s. at Birkenhead and Belfast, and 42s. in London. Joiners, again, had from 35s. 6d. to 36s. at Belfast, and on the north-east coast and the Clyde; 37s. 6d. at Barrow-in-Furness and Birkenhead, and 40s. to 41s. in London. Shipwrights had 37s. to 37s. 6d.; cabinet-makers, 36s. against 42s. in London; hammermen, 22s. to 24s. against 31s.; brass moulders, 35s. against 38s.; plumbers, 36s. against 42s.; so that it will be seen that London builders are placed disadvantageously. The difficulty is largely due to the high house rents and the distances between house and work. Of course, piece-work so



THE FLOATING DOCK ON THE WAYS, BEFORE LAUNCHING.



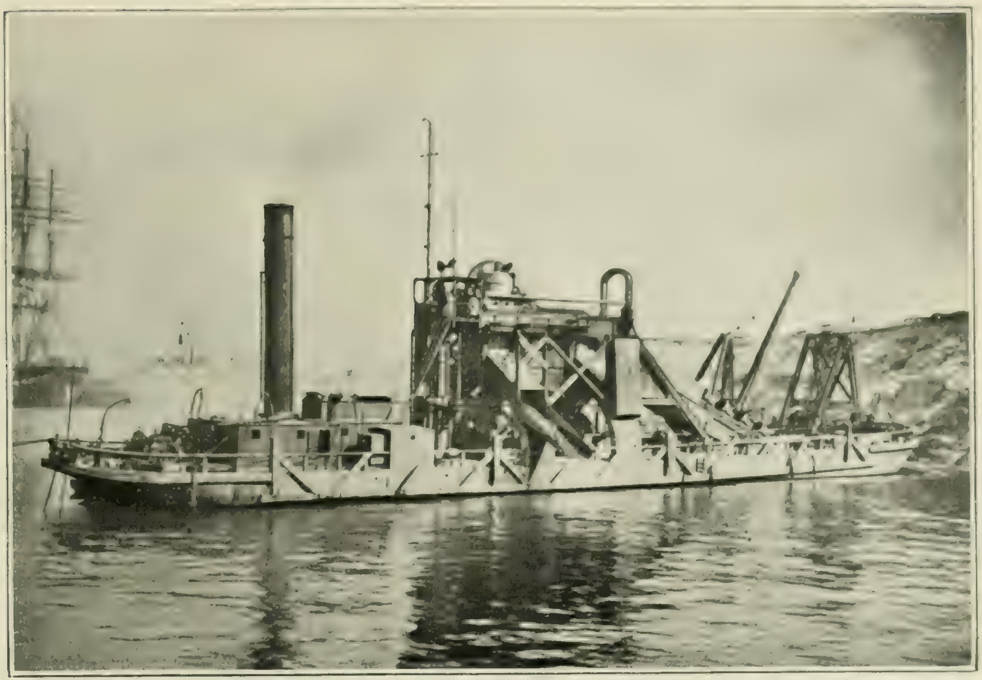
FLOATING DOCK FOR CUBA, UNDER TOWAGE.
Built by C. S. Swan & Hunter, Ltd., Newcastle-on-Tyne.

largely prevails that even the figures given are by no means applicable to all men ; but the rates, usually determined by the omnipotent organizers of labour, are about the same for each district for similar work, excepting perhaps London. It would be easy to show that the rates have increased greatly in recent years; in 1896 fully a quarter of a million workers in ship-building works, etc., got increases averaging 1s. 6¼d. per week.

Concurrently with the increasing of labour remuneration, there has been a decrease in the price of the ships produced. Some part of this has been due to the introduction of machinery, although in this respect the British firms, owing to the domination of trade unionism, do not reap the measure of advantage accruing to firms in the United States. This, however, I shall refer to later. Part of the reduction in the selling price of ships means loss to the capitalist. The published accounts of several of the limited-liability companies prove the small return of capital from ship-building. It is significant to show the national gain resulting from the cheapening of ships.

For first-class tramp steamers the price in 1883 was £14 per ton ; now it is about £10. For sailing ships the price is £5 per ton deadweight,—from 50 to 60 per cent. less than fifteen years ago. When one recalls the preponderance of those two types, and the greater economy of the steamers, it is possible to understand the cheapening of products brought to Britain from over the seas, and the ability with which she can compete for the carrying trade of other countries, which, as I pointed out in my first article, is a great source of revenue. For vessels of the intermediate class, fourteen-and fifteen-knot steamers, with passenger accommodation as well as large cargo-carrying capacity, the cost has decreased from £18 to £15 per ton. For high-speed steamers it is difficult to give an average, for the specifications differ so much, as well as the accommodation and the fittings ; but a typical twin-screw channel steamer, capable of twenty knots, with state-rooms, etc , costs from £40 to £45 per ton. Fifteen years ago this type was not in existence, the fast channel steamers being nearly all paddle-boats costing about £50 per ton. This, it will be seen, equals the cost of the high-speed Atlantic liners ; but in those vessels the machinery necessarily is costly, to say nothing of the finishing of the passenger accommodation, in which art and elegance are important items, especially in view of the higher rates of wages paid.

I have not said anything of the special classes of ship-building,—for example, dredgers which make harbours suitable for shipping of great size. These are built mostly on the Clyde, by Messrs. Simons & Co., Renfrew, Lobnitz & Co., Renfrew, and Fleming & Ferguson, Paisley, although several of the largest of special types have been built



STEEL TWIN-SCREW SELF-PROPELLING DREDGER "CAIRNDHU."

200x37x12½ ft.; capable of dredging 1000 tons per hour from a depth of 40 ft. Built for the Clyde Navigation Trustees by Fleming & Ferguson, Ltd., Paisley, 1892.

at the Barrow works. The Cairndhu, built by Fleming & Ferguson for the Clyde trust, is able to dredge 600 tons per hour; she cost £23,900; her working charges are equal to 0.41d. per cubic yard. She can dredge to a depth of 40 feet, cuts out a channel ahead of her, and steams six knots; but her dredgings are discharged into separate hopper barges, which sail forty-six miles to sea, the cost of depositing at sea being 1.21d. per cubic yard. Dredgers fitted with their own hoppers may work more economically. Again, reference should be made to the floating deck of Messrs. Swan & Hunter, of Newcastle, which can take a ship of almost any length, of a width of 82 feet, of a draught of 27 feet 6 inches, and of 12,000 tons dead weight. The docking process takes at most two and one-half hours. The dock consists of five pontoons, with side walls, and electric pumps are fitted to fill the dock, and thus lower it below a ship. The draught of the dock then is 42½ feet with a freeboard of 4 feet 2 inches. This dock was built in six months.

I have refrained from any description or comparison of the equipments of the various establishments. There is a general similarity in the machine tools of the best work; inventories would not differ materially, and to discuss the conditions determining even such variations as occur would occupy undue space.

OBJECTIONS TO THE MUNICIPAL OWNERSHIP OF PUBLIC WORKS.

By T. Carpenter Smith.

AMONG the many questions of the day probably none attracts more attention than that of the municipal ownership of public works. So far, the evidence advanced, for or against, has been of the most *ex-parte* character, each contestant presenting only the reasons, figures, or results which will sustain his view of the question, and refusing to admit, as even worthy of consideration, the points brought forward by his opponent. That this style of argument is a very mistaken policy will not, I fear, lead to its abandonment, but we may lay down as a general principle that, in cases of this kind, the final result will generally be the correct one. We may, therefore, be sure that, the more freely and fairly every fact which bears upon the question is discussed, the sooner will the truth be arrived at, and the cheaper will it be, in the long run, for all parties concerned. That there is need that the matter should be brought within the intelligent judgment of every citizen can hardly be doubted when we find in Philadelphia to-day the extraordinary combination of a strong party, headed by many of the best citizens, urging the erecting and operating by the city of an electric-light plant, while the gas works, which have been owned and operated by the city for many years, are in such a condition of dis-repair and inefficiency that, in response to the demand of an equally strong party, headed by equally intelligent and public-spirited citizens, they have been leased to a private corporation for a term of years.

The demand for a city electric plant is one that is so general in the United States as to warrant the belief that there is some real reason in it. As it is with present conditions rather than their causes that we are concerned, we may, without going into the matter too deeply, point out at once that one cause of this has probably been the action of local electric companies themselves. Rightly or wrongly, they are generally credited with having made large profits, and the general suspicion of their use of political means to gain their ends has not improved their position with the public. When threatened with competition by other companies or the municipality, they have made the mistake of not laying bare to the public the true facts in the case. Instead of pointing out, as they generally could, that their profits have not been excessive, or, if large, are fully as honest as those made in any other business, and that justice demands that their property shall not be destroyed without compensation, they have endeavored again and again to prevent competition by legislative enactment. In nearly every case these laws have been promoted and pushed in a manner to create public suspicion instead of public confidence, and so far, therefore, they have generally failed of enactment, and the companies are confronted to-day by a still more bitter feeling against them. Meanwhile the cities have been the victims of visionary theorists, unscrupulous politicians, and greedy promoters, who know little and care less about the true costs of the schemes they propose, but who desire either to pose as public benefactors, to gain political favor, or to earn the wages of go-betweens. The constant report of wonderful results (with half the data necessary for an honest decision left out) always gains a large number of honest supporters, who lend the necessary character to what we may almost call a craze.

The first step towards clearing away the haze surrounding the question is to recognize at once that there is a very great difference between municipal ownership of public works combined with municipal operation, and municipal ownership of works operated by an independent concern under municipal control by lease, contract, or other suitable arrangement.

I do not, in this paper, purpose going into this very wide question, but shall confine myself strictly to the division of it which is at present the most interesting, because the most common,—namely, shall a city put in and operate a gas or electric light plant?

To consider broadly the question whether a municipality should own and operate its own gas or electric light plant, we may examine it under three great heads. First, has a municipality the legal right to do this? Second, has it a moral right? Third, is it good policy? Under each of these heads subdivision is necessary, to distinguish cases where there is a plant operated by private parties, the value of which would be either destroyed or depreciated by the competition of the municipality, and, further, to distinguish between municipal lighting of the streets and public properties only, and the business of furnishing light to all who desire it. All these various divisions and sub-divisions can be easily followed by reference to the table appended.

The legal right it is useless to consider here. The whole matter depends purely upon the charter of the corporation, and the way in which it was received; and, being a question of law, it will be decided by the courts, from which there can be no appeal

Under the head Morality, the case (A) where there is not already a company in existence and the plant is to be used for public lighting only is so largely the same as the cases (C and E) under the head Expediency that we may dismiss it for the present, and consider first the case (B) where, with no other company in existence, the intention is to use the plant for general commercial lighting.

- LEGALITY: Not open for discussion.
- MORALITY:
  - No Local Company, already operating.
    - Plant to be used for city purposes only. (A)
    - Plant to be used commercially. (B)
  - Local Company, already operating.
    - Plant to be used for city purposes only. (C)
    - Plant to be used commercially. (D)
- EXPEDIENCY:
  - No Local Company, already operating.
    - Plant to be used for city purposes only. (E)
    - Plant to be used commercially. (F)
  - Local Company, already operating.
    - Plant to be used for city purposes only. (G)
    - Plant to be used commercially. (H)

A city being organized for the purpose of carrying on ordinary municipal business, it is not a part of such business to engage in manufacturing or other pursuits for the purpose of making money. The ideal municipal government is that in which the expenses of government are exactly covered by the taxes, and in which the city has, so to speak, no profit or loss to show at the end of each year. Now, any commercial business is carried on either at a profit or at a loss. If the city's business of gas or electric lighting is to be carried on at a profit, then those citizens who use gas or electric light will be charged a high price for that light, in order to pay a profit, not only to themselves, but also to those who do not use it. If the works are to be carried on at a loss, then the citizens who do nót use the gas or electric light will pay taxes to furnish a convenience or economy to those citizens who do use it. If the works are to be operated exactly at cost, then the city will carry on a business from which it will get nothing, but in which it will have to take the labor and risk incident to such a business in order to benefit some only of its citizens, furnishing a commodity not desired by all. It is evident that in such case the city should not engage in such work at all, unless we desire to create a Socialistic system.

At this point we are confronted by the argument constantly brought forward that the furnishing of gas and electric light to the citizens stands on the same footing as the furnishing of water, and that the same reasons may be urged for the city's ownership of gas or electric-light plants as for its ownership of water works. The cases do not seem parallel. Let us look at some of the chief reasons why the city should own water works. First, there is no substitute for water, which is an absolute necessity of life. The city may, therefore, plead an obligation to see that each inhabitant has a means of getting water, and also that each citizen pays for his use of it. It may be here mentioned that in some cities properties are taxed for water, whether they have a connection with the pipes or not, the ground being taken that, as water is a necessity, the occupants of such property must use their neighbors' water-supply. It may be urged that the citizen who has a private means of supply should not be taxed, since he can use this, instead of taking water from the city; but here the question of public health steps in. Experience has shown that such means of supply, to be perfectly healthy, must be far beyond the reach of the ordinary citizen, and that to allow the indiscriminate use of what individuals may consider suitable for their purpose will most certainly result in sickness, which will affect not only the individual, but the community at large.

Again, the water-supply of a city is constantly required and used for fire protection, and since, for this application also, no general substitute has been found, adequate protection requires that each and every house shall be secured against fire. This function is, in fact, a branch of the police power, which forbids a man to do things dangerous to himself, lest they may endanger his neighbors.

As against the fact of there being no substitute for water, we have a great choice in methods of illumination. One man may prefer coal oil, another may prefer gas, and another may prefer electric light. Experience has shown us that all of these may be made measurably safe, and the only fair way, therefore, in which to supply this want of the citizen is to allow him the freest selection, while placing the general serving of the commodities under strict regulations as to safety. Thus we find, in nearly all cities, ordinances providing that no oil must be sold below a certain flashing point, that the piping in buildings must be thoroughly tested before it can be used for gas, and that electric light wiring must be done under certain rules to prevent danger to life, while behind all these stand the insurance companies with their requirements, of even greater strictness. There is, therefore, no pressing necessity for the city to engage in the business of supplying either oil or gas or electric light to the citizens, and we may fairly conclude that, on the score of morality, the decision is against it.

Coming now to the case (C) where there is already a plant operating in the city, and it is proposed to erect a municipal plant for public service only, we may partly consider with this the former case (A) of a municipal plant for public service only in a city not already having a company. I believe that there can be no moral objection to municipal ownership and operation of a plant of any kind if used exclusively for the needs of the community as a whole, provided always that the city has not, by direct or implied contract, caused the local company to invest capital in apparatus or property to be used for the purposes of the city, the value of which would be destroyed or depreciated by abandonment of the contract by the city. It must be distinctly understood, moreover, that it is not at all necessary that there should have been a formal contract for a term of years; a mere assenting of the city to such investment by the local company constitutes a moral obligation on the part of the city to either maintain such contract, purchase or pay for such property or apparatus, or give such notice of termination of the contract as will permit the company to gradually dispose of, or retire from use, this material without undue loss.

Coming to the case (D) where it is proposed to apply the city plant for general commercial lighting, we at once see that not only does every argument which applied in the case of the last sub-division hold with equal force in this, but we have in addition a new set of conditions, and new arguments to apply. In the first place, the city would be using its total power to compete with a part of itself; it would be in the position of having granted a franchise upon which large sums of money had been spent and investments made, and then proposing to destroy or seriously injure it, and it would be entering upon a course which was certainly not contemplated when it received its charter for the purpose of exercising municipal duties. If it be right for a municipality to enter into the business of supplying its citizens with gas or electric light, then it is equally right for it to enter into the business of supplying coal, or dry goods, or any other commodity, and, as said above, this it cannot equitably do unless we wish to establish a Socialistic community. Under the conditions under which nearly all gas or electric-lighting companies have been established, for the city to establish a competing plant would be dishonorable in the extreme. The argument is often made that the city has presented these companies valuable franchises for which they have not received adequate return, and that this is sufficient reason for not making any compensation to the companies for now injuring them ; but it certainly is a new idea in morality that, when a contract disappoints, it may be disregarded without penalty. It must be remembered that, at the time these franchises were granted, it was a very uncertain question whether the business would ever pay ; so much was this felt to be the case that in some cities there are laws still existing which give the first company entering into the business of supplying gas or water an absolute monopoly within certain districts. It is true that, when it was decided in Pennsylvania that electric-light companies did not come under this general law, the legislature refused to grant such monopolies to the first companies which had received charters, and left the field open to all, but it must be remembered that this decision was not arrived at until electric lighting had been for many years an established business, and had proven that it was likely to be a success. That it has not been such a success as was anticipated the books of nearly every electric light company will show. If the history of many gas companies now paying well were gone into, I suspect a good many would show in their early years—now buried and forgotten—an awful record of anxiety and loss. There is greater reason for competition among water companies than for competition among gas or electric-light companies, since, as already said, water is a necessity for which there is no substitute, and the temptation to make the monopoly oppressive is therefore very much greater than in either of the other industries. Clearly in this case a municipal plant would be not moral.

Under the head Expediency, we will reverse our order of consideration, taking first the sub division (H) where a company is already in existence and operating, and the city plant is to be used for the general supply in competition with it. We may say at once that this would not be expedient, since it would be (as shown under the consideration of D) not moral, and for a community at large nothing which is not moral can be expedient. This will equally apply to the case (F) where there is no plant, and the city proposes to do commercial lighting, which we have shown to be not justifiable in case (B). Dismissing these, we may consider the case (G) where the plant is to be used for public lighting only ; here a great number of points have to be taken into consideration. If the city has been receiving light from the company and has to pay it some compensation for the withdrawal of the city's patronage, the chances are that the city's plant will cost it as much as the similar plant put in by the company, the compensation payment more than making up for any fall in prices of material since the original installation. As to operating cost, the chances are that this will be greater for the city than for the private plant. There are undoubtedly cases where municipalities do operate both gas and electric-light plants and secure their lights at lower rates than they can obtain from a local company, but it is equally true that these cities can lease their plants to an operating company and make more profit than by operating themselves. Moreover, as the public lighting for a city is generally but a small amount of the total lighting done by the company, it is only reasonable to suppose that the cost per lamp will be less for a large number of lamps than for a small number, and that consequently the city could buy its service from the local company, under a truly equitable contract, at less real cost to itself. By this means also it at once cuts off an uncertain element in its expenses, and knows that for a certain sum per year it can receive certain service. That this is an advantage in making the tax rate can hardly be denied.

The other considerations in determining the question of expediency apply equally well in the case (E) where there is no plant operating in the city; accordingly, we may now take this item into the discussion. The average electric-light station which is confronted by the question of a municipal electric-light plant usually founds a great deal of its argument in opposition upon the supposed fact that a municipality cannot operate a plant as cheaply as a private corporation can. This form of statement is a mistake. There is no reason why it cannot, though there is little doubt that, as a rule, it does not. We cannot, however, by faulty experiments, disprove a law, and accordingly we may as well at once point out wherein it is that municipalities do fail in cheap operation, and where they could, or could not, amend this state of affairs. In the first place must stand, of course, the well-known fact (gloze it over as we may) that in America, at least, average city employees are neither as competent or as honest in their work, and do not do as much for the money, as those employed in private corporations. Again, the temptation to use the patronage of the city business is a constant source of corruption among city officials.

It is not many years since the *régime* of the "Gas Ring" in Philadelphia, which was so notorious as to be selected as an example in Bryce's "American Commonwealth"; and it is this order of things, bettered a little, that a large number of citizens are supporting.

To offset these sources of excessive cost, the temptation is to furnish returns which are not correct, making no allowance for interest on cost of plant, charging no taxes against it, not making allowance for the water furnished to it by the city, making no allowance for depreciation of machinery, perhaps providing no sinking fund to take up bonds which have been issued to pay for the plant, charging nothing for wages because the men who already operate the water works also operate the electric-light plant, etc.,—all or any of which omissions may deceive those who have not ingrained in their mind the principle that you cannot get something for nothing, and that all work done must be paid for somehow, though it may not appear in the bill at first sight.

Of course the ready answer to this is that the city's business in every department should be as well administered as that of a private corporation (which, in fact, a city is), and its employees should be selected purely for their fitness, and held to a strict accountability for the proper performance of their duties; and objectors are continually invited to witness the magnificent results which, under such conditions, have been attained with civic plants in Europe. While excellent results are undoubtedly attained there, it is a question whether the best results of all have not been reached in those cities which, owning public franchises, leased them to corporations, or even granted the franchises bodily to outsiders, making with them strict contracts for regulation of the service. Moreover, we have to deal with circumstances as they are, and not as we should like them. After all, the real cure is to get the public service into the hands of competent and honest workers, and the greatest obstacle in the way of this consummation, so much to be desired, is without doubt in the United States the present office-holder, and the man who puts him there. It is too often true in America, and perhaps elsewhere, that the member of the governing body of a city, who takes his place without salary, and who is (as very often happens) a man with practically no business, holds this office for "what there is in it." His ability to be elected depends largely upon the number of places that he can control, and to cut off his possibility of appointments removes the chief reason of his being in the position. He will not stay there for glory, and with his departure goes the greatest hindrance to honest and effective administration.

And now what are we to consider the best method of avoiding these various troubles? To the municipalities, on the one hand, whose vision has been dazzled by the prospect of escaping from the thraldom of a company supposed to be charging excessive prices, and putting in a plant which shall be the only plant in the country to make no mistakes, cause no corruption or jobbery, and so turn in a handsome profit to the taxpayers, and to the gas or electric-light company which sees its business threatened, its investments in danger, and itself continually held up to public odium, some just and equitable settlement naturally seems a desirable consummation.

Many years ago, among electric-light interests, I strongly advocated the formation of a commission for this end, not knowing at the time that the gas and electric-lighting commission of Massachusetts was filling this very purpose.

To those who urge the difficulties usually met with in commissions I say that much of this comes from the character of the men chosen. Such a commission must consist, not of politicians, or lawyers, or legislators, whose very connection with the case will make the public suspicious, or of professors and teachers, who have too little experience of the practical side, but of the very best business men and manufacturers in the community, for only men of this kind can fully appreciate the circumstances. They must be men to whom can be opened the books and the whole history of the contracting parties. They must be men of such reputation and standing that, when they state their verdict, whether the compensation is to be one dollar or one million dollars, the community will accept it absolutely and without hesitation. They must also be men of such character and position that, no matter what the public misunderstanding of their finding may be, they can bear the responsibility. I do not expect to get good results, at least under existing American conditions, from a commission whose members will serve without pay, or for a mere pittance; I would take only men whose services can demand high salaries, of which the State or city should pay half and the companies affected the other half. It will be a small price for either side to pay, compared to the interests at stake.

Lincoln once said that you "can fool all of the people some of the time," but the time has gone by when all the people can be fooled on the question of gas or electric-light monopolies, and it behooves all concerned to use their utmost endeavors, lest the swing of the pendulum shall work their destruction, grossly unjust perhaps, but none the less overwhelming.

THE EQUIPMENT AND ORGANIZATION OF A CITY FIRE DEPARTMENT.

By Hugh Bonner.

THE occurrence of a great city fire is usually, and not unnaturally, productive of the keenest interest and the most active discussion, often continuing long after new structures have risen upon the ruins of the old ones.

The property interests involved are so large, and the menace to life so great from fire in thickly-built districts, that attention is deservedly drawn to two great systems of safeguarding: first, systems of architectural construction which will make it extremely difficult for a building to take fire, or, if fire be started, to burn with rapidity; second, the most carefully organized and highly efficient system of confining and extinguishing a fire.

European cities are generally distinguished—strikingly so to an American—by the development of the former principle. In the United States, on the other hand, the chief dependence in most cases is now, and for some time must be, the efficiency of the fire department. While the heavy insurance losses on American risks and the proportionately high rates which are general, in spite of the highest organization of the protective service, suggest that prevention should coöperate with control, the recent great disaster in London has awakened active interest in the maintenance of a fire-fighting force which shall be adequate to any emergency arising in the largest cities.

It will be of interest, therefore, to study the system of organization and equipment of a typical American fire-brigade, and I shall take for an example the fire department of New York, as it existed at the end of 1897.

The fire department of the city of New York has an aggregate of 1,146 officers and men, divided into 61 engine companies, on land, 3 companies on fire-boats, and 22 hook and ladder companies, a total of eighty-six companies. The number of men assigned to each varies with the locality, but does not exceed a total of 12 (including two officers and two engineers) except in nine engine companies, which are classed as double companies, with the necessary complement of men to operate two sets of apparatus. Each section of these double companies is really a company in itself, and, in the absence of one section, the other performs duty in the territory thus left vacant. The same conditions apply to one hook and ladder company, which has a double set of apparatus, officers, and men, the second section being classed the same as the second section of a double engine company and either assigned to cover the ground during the absence of a regular company, or held in reserve during large fires. Attached to some of the hook and ladder companies are chemical engines, which operate in the districts of the hook and ladder companies, but have an extra force in charge of them.

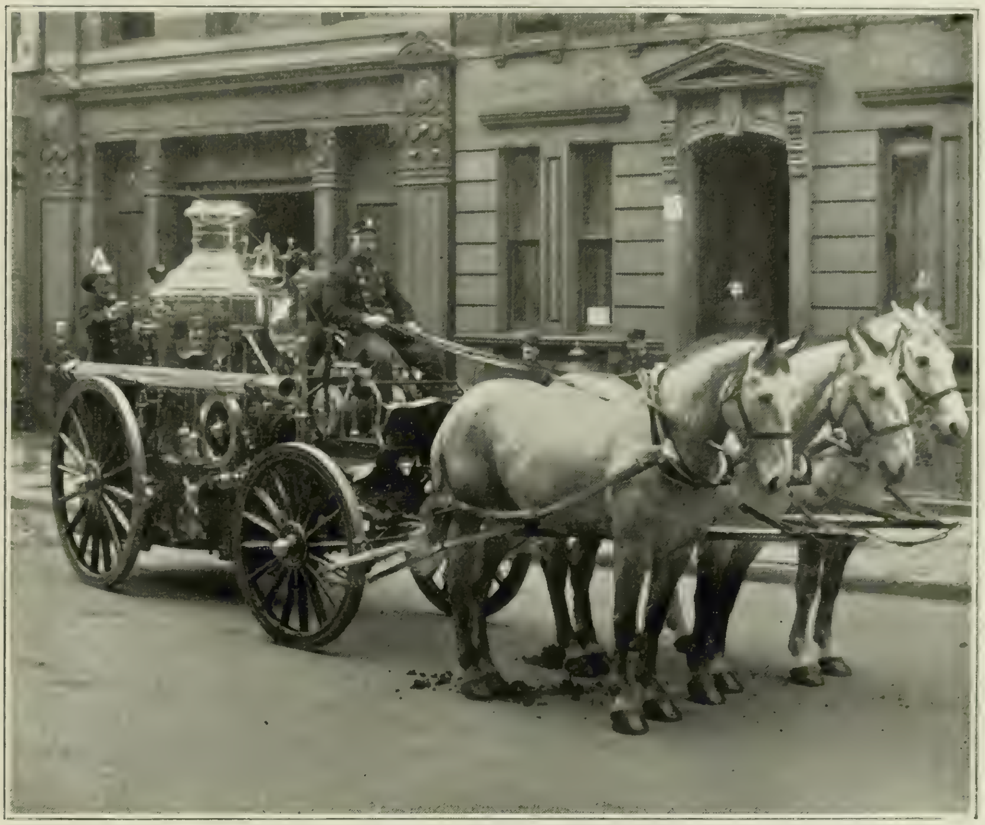
The department is divided into fourteen battalions, with from five to eight companies in each. The battalions are again sub-divided into three sections, and assigned to the command of a deputy chief of department, the whole force being under the direct command of the chief of department. The uniformed force consists of the following officers: chief of department, three deputy chiefs of department, one chief instructor, fourteen chiefs of battalion, eighty-six foremen, ninety-six assistant foremen, and the necessary complement of engineers,—two to each company, except in the double companies, each of which has four.

The chief of department is directly responsible for the management and discipline of the entire uniformed force and for the extinguishment of fires, and in turn is responsible to the board of fire commissioners, which body consists of three citizens, appointed by the mayor, for terms of six years each.

The duties of a deputy chief of department are to assume command in the absence of the chief of department, enforce discipline in each battalion under his charge, make inspections of the officers, men, uniforms, apparatus, horses, quarters, etc., and see that all officers are efficient in their duties.

The duties of a chief of battalion are to assume command of his battalion, regulate all the details therein, enforce discipline, visit the several company quarters in his battalion district, supervise the extinguishing of fires at which he arrives first, and forward to headquarters each morning all official papers, reports of operations at fires, etc., through the headquarters of the deputy chief to whose district the battalion belongs.

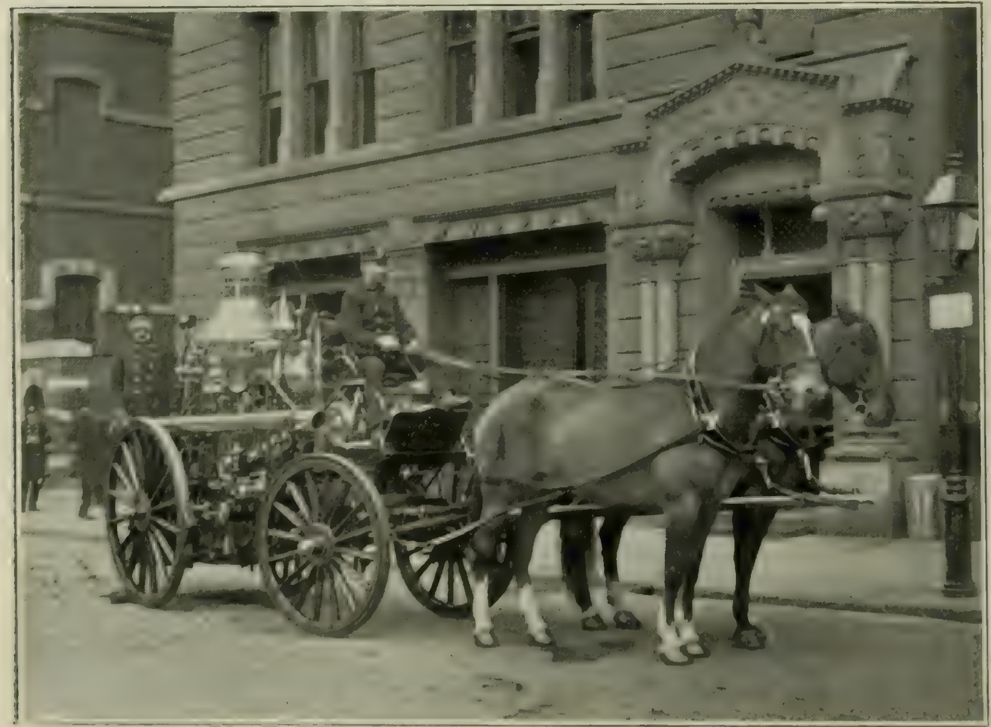
Each company has a foreman and an assistant foreman. The former is the officer in command, and is responsible for the control of his men, uniforms, discipline, etc., as well as horses, apparatus, tools, implements, and public property of all kinds entrusted to his care. He makes a return of this property annually to headquarters, and a proper record is kept. To each company is allotted a section of the city, which is classed as a company district, and for which the commanding officer is responsible. He is required to see, so far as details are concerned, to the enforcement of all laws relative to prevention of fires, storage and sale of explosives and combustibles, alterations in buildings, exits and entrances, iron shutters, the care and condition of hydrants, obstructions to fire-escapes and their condition, the condition of streets and avenues, and every matter pertaining to the fire department. If it is not within the power of the commanding officer to correct any existing evil, he must immediately take action by forwarding the necessary reports to headquarters with a view of abating or remedying the evil at the earliest moment. He is also required to make a report each morning after roll-call at 8 o'clock A. M., and to transmit the same to his battalion chief, showing the exact number of men ready for duty, those who are absent and for what cause, reports of operations at fires, etc.; and these are in turn transmitted to the deputy chief of department, and by him to the chief of department at headquarters, where all such reports are consolidated and a record kept for future reference.



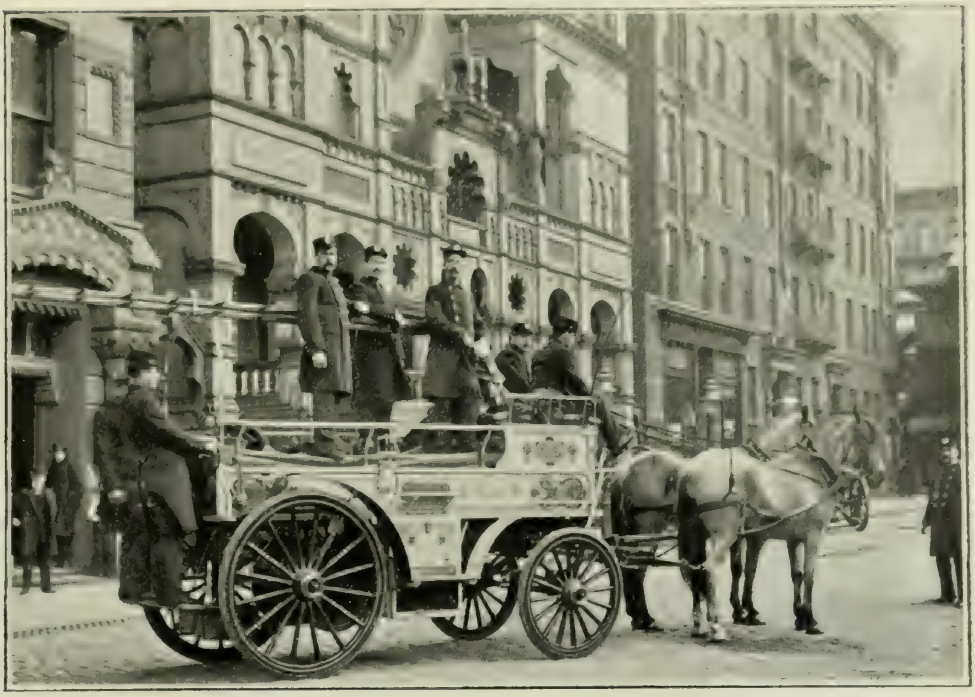
A THREE-HORSE FIRE-ENGINE OF THE NEW YORK DEPARTMENT.

Engine companies are equipped with engines of a capacity of from 350 to 1,100 gallons per minute. The heavier engines are arranged to operate with three horses, and weigh, when ready for use, about 11,000 pounds; those of smaller size are usually located in the suburban district, do not weigh, when ready for use, more than 5,500 pounds, and, as a rule, are equipped with two horses. The engines are complete in every respect, and, while standing in quarters, are connected to a heater in the cellar, which permits a circulation between the two boilers with the object of keeping on the engine boiler from 5 to 25 pounds of steam, which is necessary in all cases to give a prompt water-supply at fires in the vicinity of company quarters. The engines have tool-boxes containing all the tools used on pumps, machinery, and boilers. Ash pans with space sufficient to carry fuel for an hour's duty are on the back of each engine.

Hose wagons are drawn by two horses, and are equipped with 1,500 feet of hose, a section of large tapering hose, two scaling ladders, life lines, life belts, life gun, life net, roof rope, wrenches, siamese, pipes, nozzles, and hose hoisters. The hose varies in size from 1½ to 2½ inches in diameter. Hose wagons of the first size attached to engine companies carry 1,000 feet of three-inch hose, 500 feet of 2½-inch hose, and 600 feet of 1½-inch hose. The small hose is generally used at small fires, while the three-inch hose is used on larger fires or where more than one alarm is necessary. The wagon carries all the men, and follows the engine to the scene of the fire. The hose wagons are supplied with rubber hose and rubber-lined cotton hose, and, after use at a fire, the wet hose is replaced by dry.

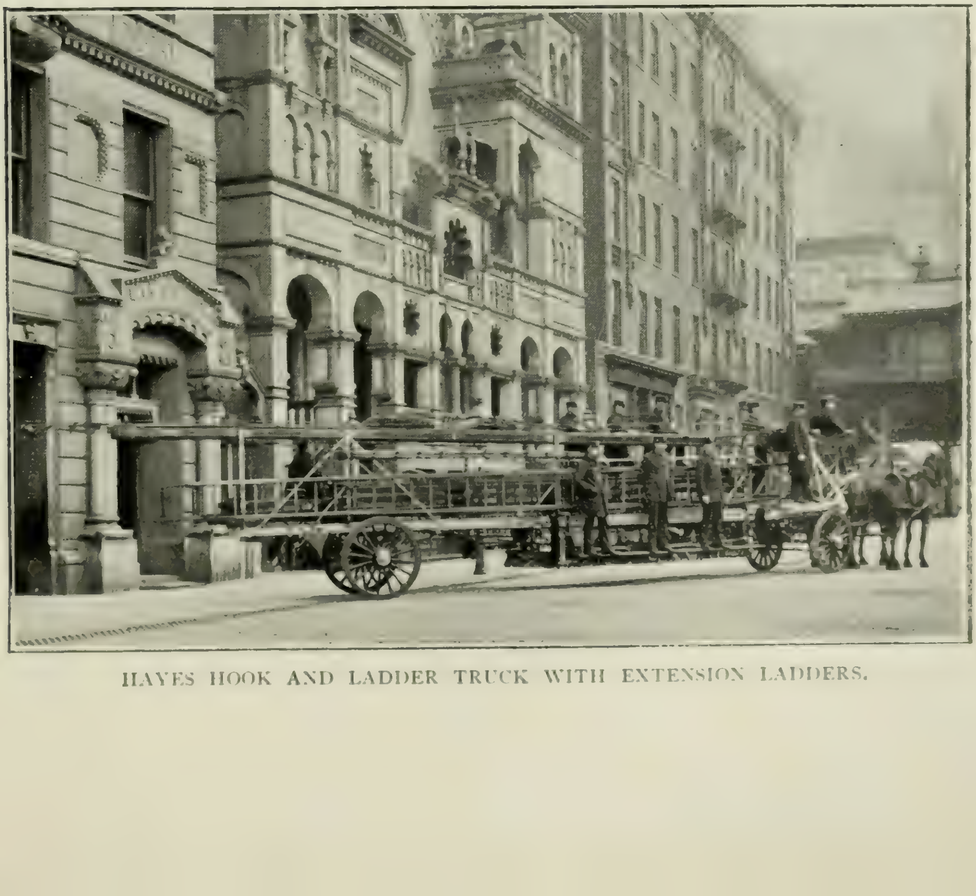


A TWO-HORSE FIRE-ENGINE.

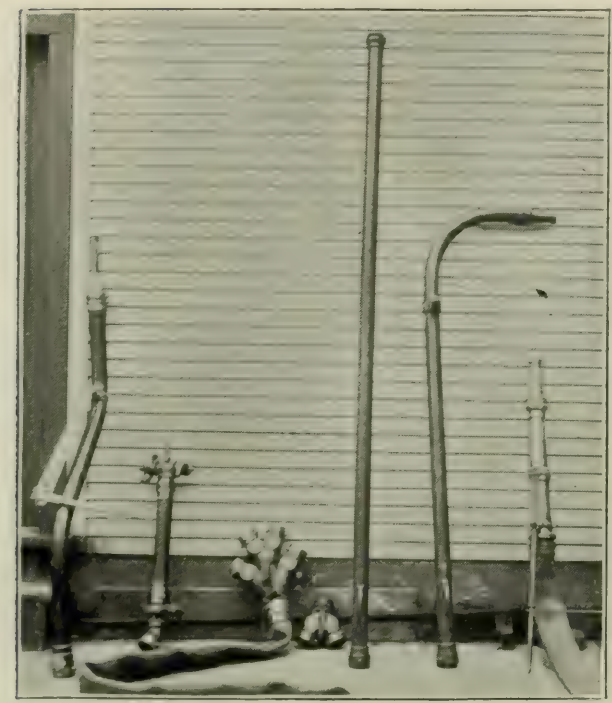


A NEW YORK FIRE DEPARTMENT HOSE WAGON, CARRYING SCALING LADDERS.

A hook and ladder truck of the first size is equipped with an 85-foot extension ladder, carried on a frame, with the butt resting on a turntable; the ladder is elevated by the use of cranks on each side. An aerial ladder can be elevated to a height of 85 feet in about one min-



HAYES HOOK AND LADDER TRUCK WITH EXTENSION LADDERS.

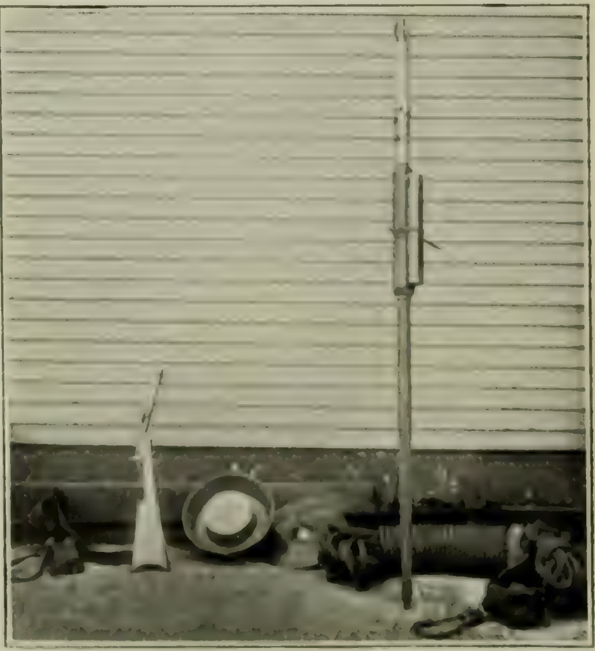


GROUP OF HOSE CONNECTIONS.

Cellar Pipe. 4-way Connection. Sub-cellar Pipe.
Distributing Nozzle. Siamese. Street Pipe.

ute. The other ladders vary in length from 10 to 50 feet. The truck is also equipped with scaling ladders, life lines, life belts, tools and implements, such as hooks, axes, mauls, augers, saws, hammers, cellar and sub-cellar pipe, spherical nozzles, two way siamese, 4-way siamese, 3¼ inch hose-pipes, nozzles, roof lines, hose hoisters, ball and chain, battering ram, door-opener, wall-cutter, tin-cutter, life gun, rope ladders, claw irons, tapering hose, and fire extinguishers.

Chemical engines, which in a number of cases are in use with hook and ladder companies, are drawn by two horses, and carry two sixty-gallon tanks of fluid, resting on an iron frame. When equipped and loaded, they weigh about 5,000 pounds, and are made ready for use, when they arrive at fires, by turning the sulphuric acid carried in a jar inside of the tank. The acid, when mixed with the soda, generates a pressure in the tank which forces the fluid through a small hose, and throws it on the fire. The water thus charged with carbonic acid gas is highly efficient in holding in

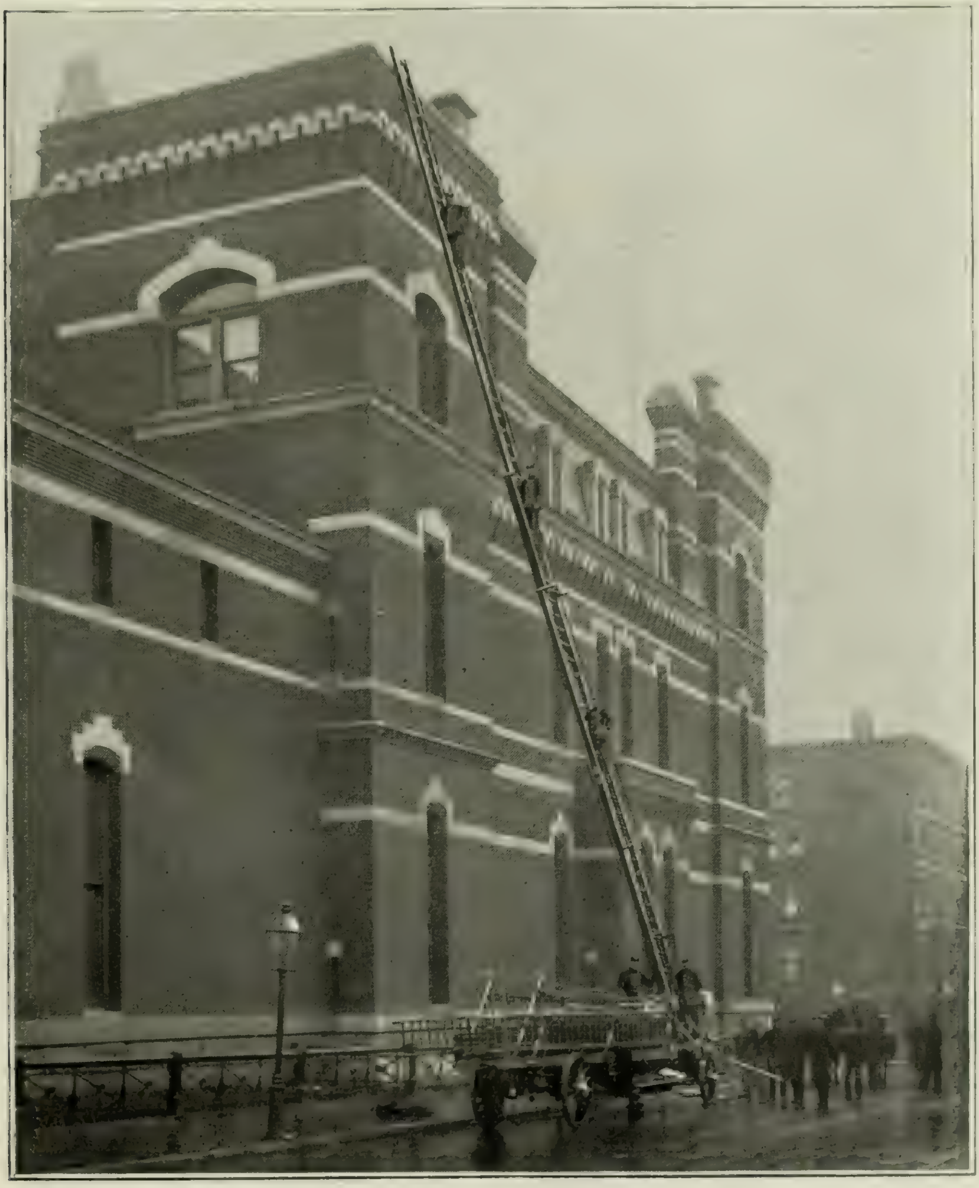


LIFE-SAVING APPARATUS.

Life Belt. Life Gun. Large Life Gun. Life Line.

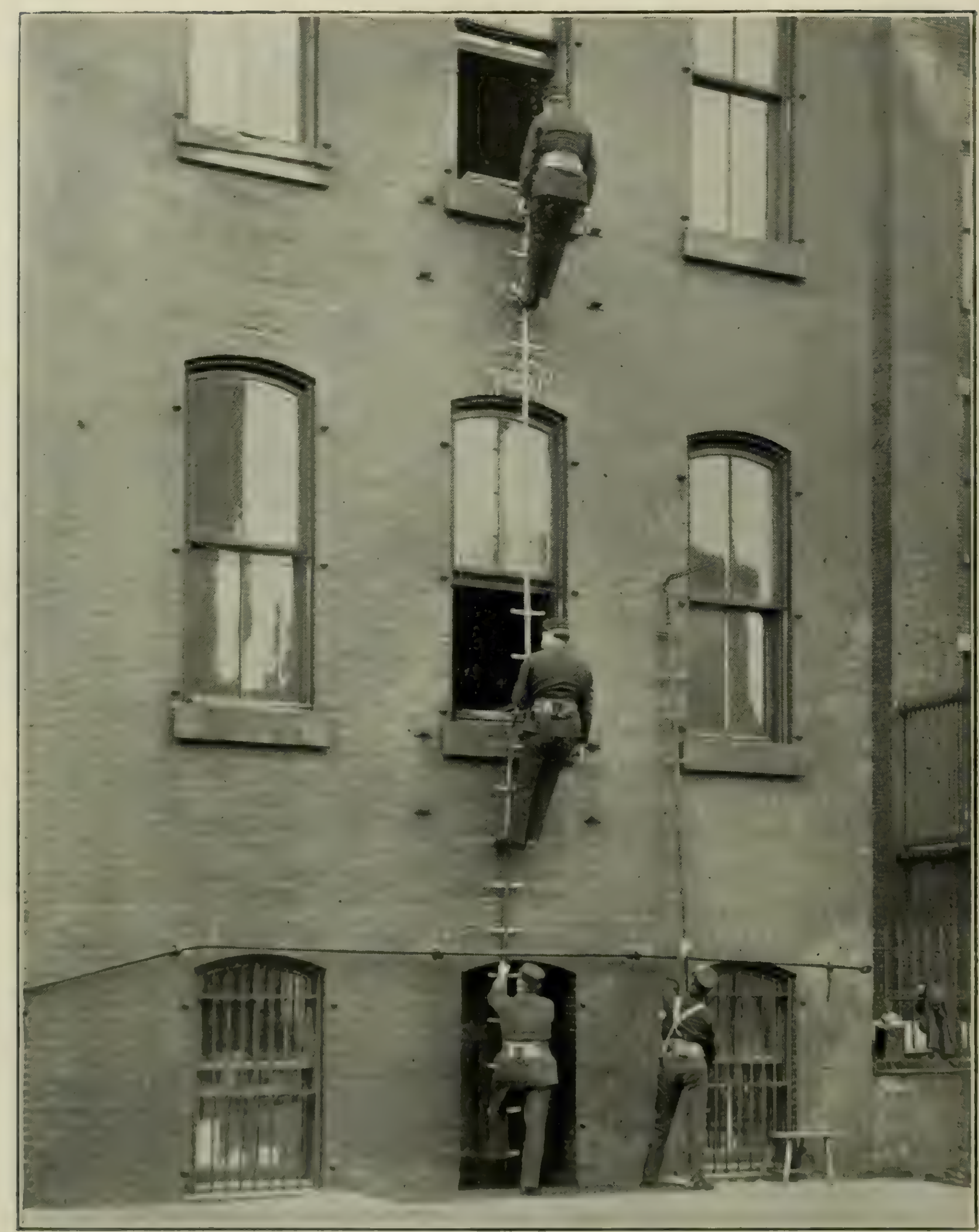
The large life gun, which is shown with line attached ready for use, will throw a line 1000 feet high.

check and extinguishing a fire of considerable magnitude. The chemical engines are generally used in dwelling or suburban districts, or in districts where the water-supply is scarce, or where there are not enough engines to cover the district.



THE HAYES TRUCK, WITH LADDER EXTENDED.

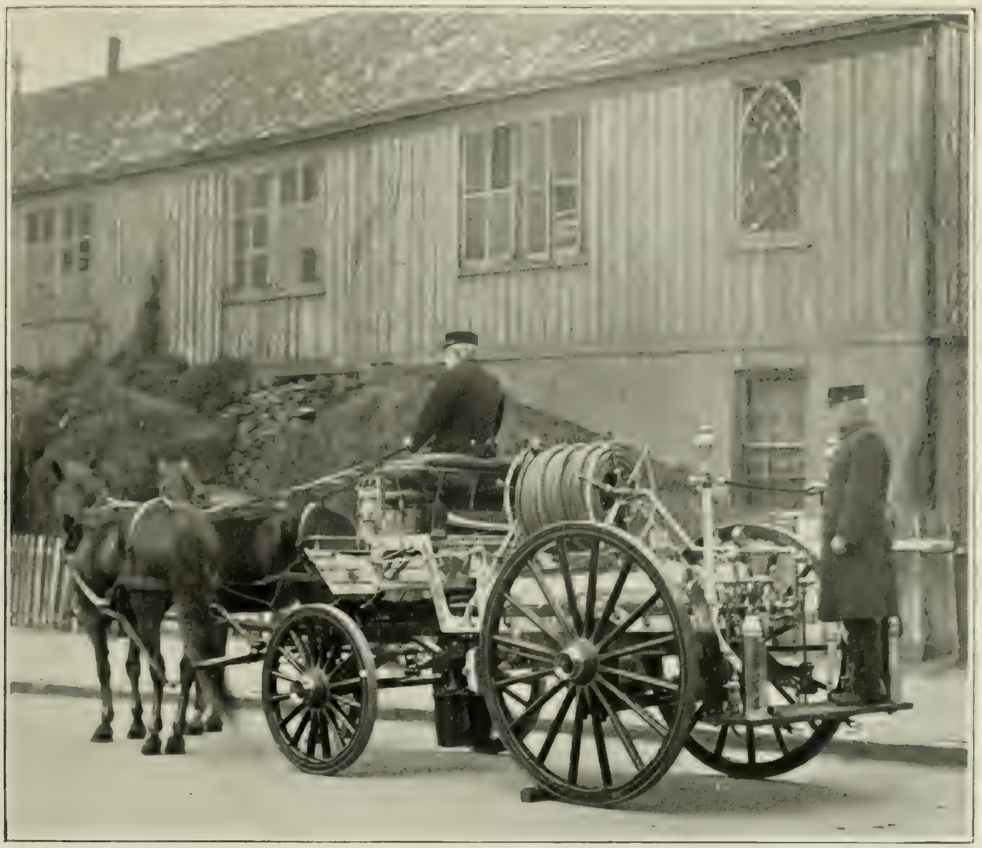
Three water towers are used in conjunction with the hook and ladder companies, and are operated by an extra force of men assigned to those companies. The towers are drawn by three horses, and are constructed to receive from two to six streams of water on each side of the frame. These streams are discharged into a reservoir and then



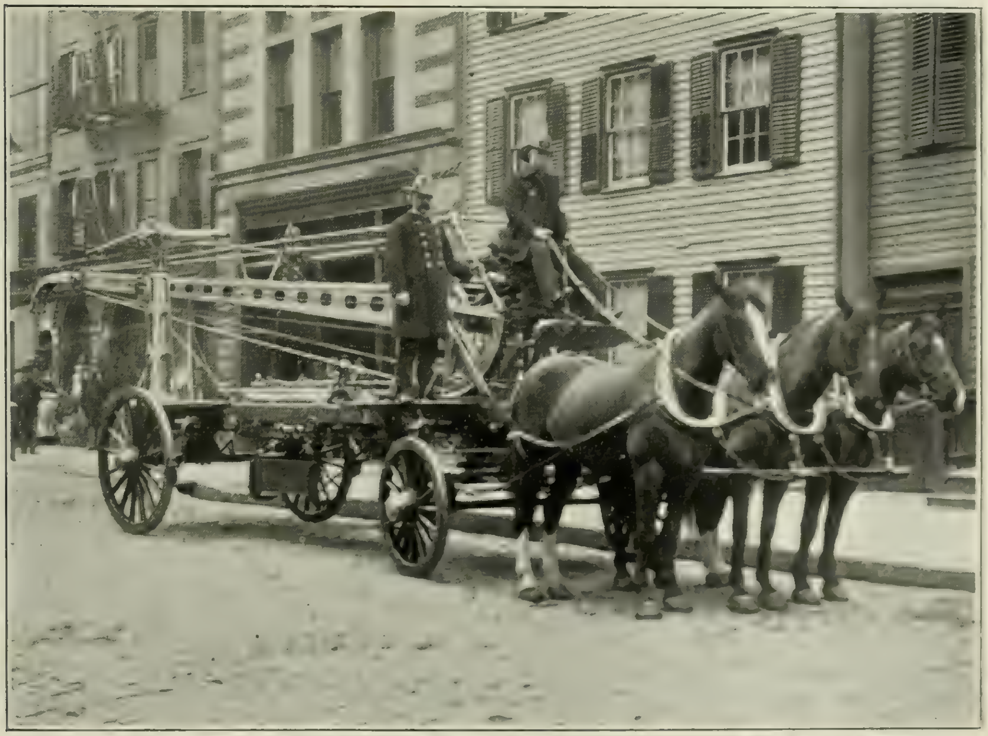
SCALING LADDERS, AS USED BY THE NEW YORK FIRE DEPARTMENT.

through a 3½-inch hose, which passes through an iron frame about 25 feet in height, and which is elevated to a perpendicular position by water pressure. There is also a 50-foot extension-piece, which operates within this frame.

The streams thrown by the water tower vary in size according to the supply furnished to the reservoir, depending for this on the number of engines which can be spared for this duty. The object of this standpipe is mainly to operate in the upper part of the building; for



ONE OF THE CHEMICAL FIRE-ENGINES OF NEW YORK.

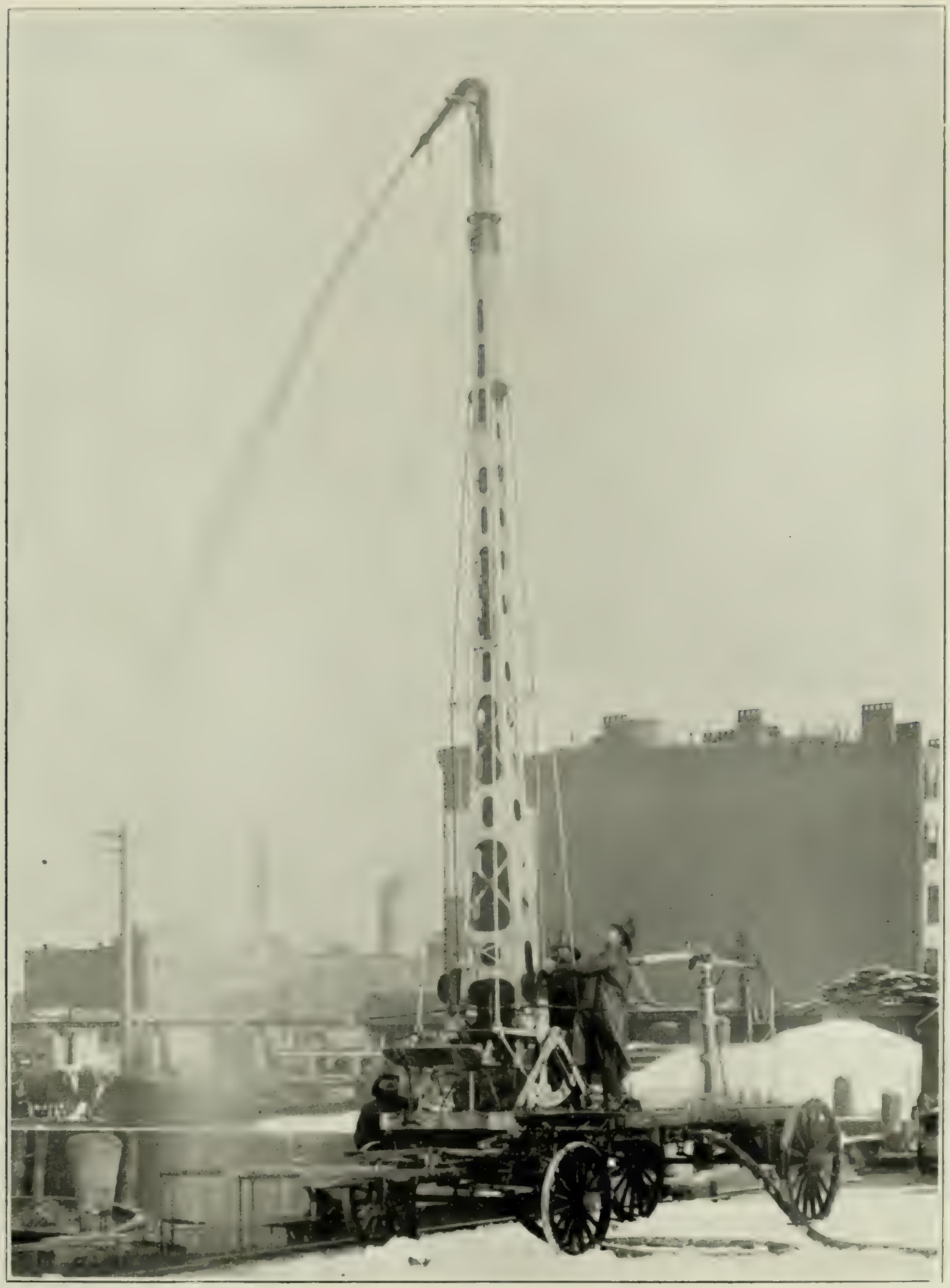


THE WATER TOWER, LOWERED FOR MOVEMENT THOUGH THE STREETS.

such a situation, it affords a convenient and efficient means by which great quantities of water can be discharged when the extent of the fire warrants it. There is also a deck pipe attached to these towers, about six feet in height, connected to a similar reservoir, and fed in a like manner; it is operated from the deck of the tower by the use of a lever. Streams from this pipe can be utilized in the cellar, the top floor of a building, or may be directed toward any point of the compass, and are mainly used on the lower floors directly under the streams from the stand-pipe.

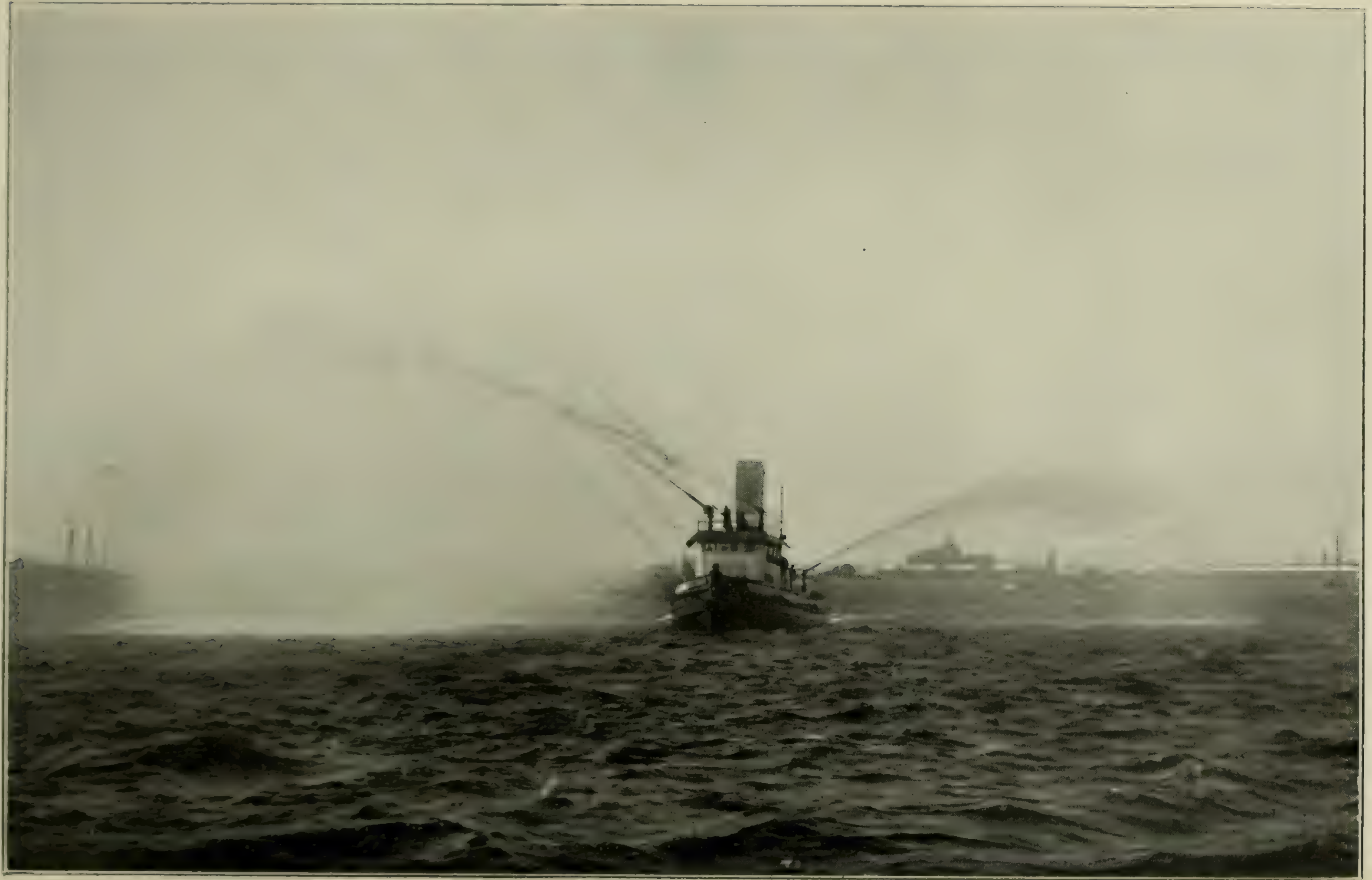
The fire boats are three in number, with capacities of 2,500, 3,500, and 13,000 gallons per minute, and are located on the East and North rivers, and at the Battery, and perform duty on the river-fronts in protecting the large piers and shipping, as well as on land to a distance of 1,000 feet from the bulkhead line. They are equipped with hose 2½, 3, 3¼, 3½, 4, 5, and 6 inches in diameter; there are

NEW YORK FIRE BOAT "NEW YORKER."



THE WATER TOWER, RAISED AND IN OPERATION.

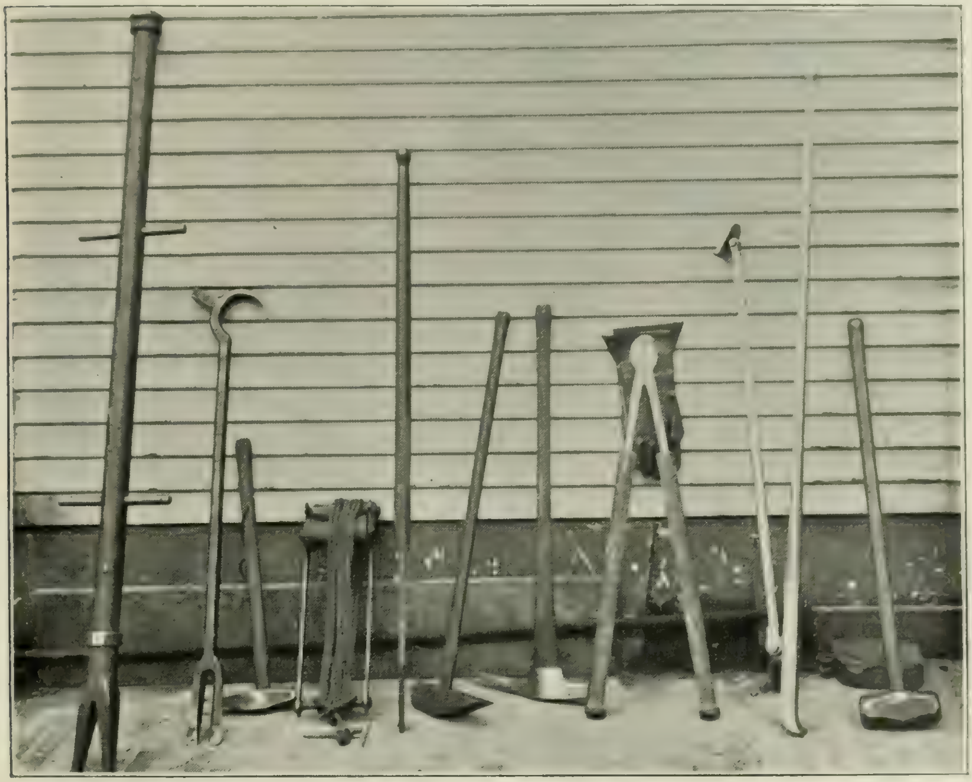
swivel nozzles on deck and on top of the pilot house, and discharge gates on pumps from sides and fore and aft, with the necessary complement of pipes, nozzles, and wrenches for all sizes of hose. Two of these boats have hulls and upper bulwarks of steel, and are fully capable of entering any bulkhead or side of a pier, no matter how hot the fire. They are intended for such emergencies, as well as for re-



THE "NEW YORKER," ONE OF THE FIRE BOATS OF THE NEW YORK DEPARTMENT, WITH ALL STREAMS PLAYING.

moving burning vessels from their berths, and hauling them to places of safety.

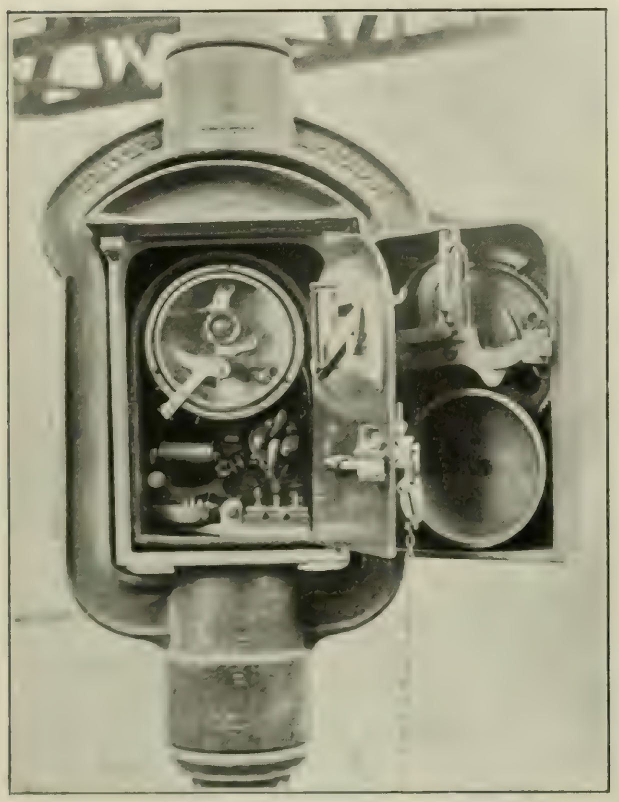
The boats often receive alarms for fire on shipboard, from vessels that have reached the Highland Lights, going to, or returning from, sea voyages ; they go to meet the vessels, and take entire charge of the extinguishment of the fire before the vessels reach their docks. The boats are also available for duty on either shore, when called for by the authorities. They are manned by one foreman, one assistant foreman, three engineers, two pilots, three stokers, and eight firemen.



GROUP OF TOOLS CARRIED BY A NEW YORK HOOK AND LADDER COMPANY.

Battering Ram. Maul. Tin Cutter. Pick Axe, Door Opener.
Lock Opener. Hose Hoist. Cutting Maul. Electric-Wire Cutter. Sledge.

The fire-alarm system receives at the central office all alarms from the various boxes or stations, which are marked by a red lamp. The alarm box is attached to the lamp-post, and has a keyless door. On its face is a brass knob ; also its number. Turning of the knob operates an automatic gong in the door, which announces to those in the vicinity that the box is being opened. From the front of the inner box a hook projects, and the pulling down of this hook once and letting it go starts the machinery in the inner box, and registers at

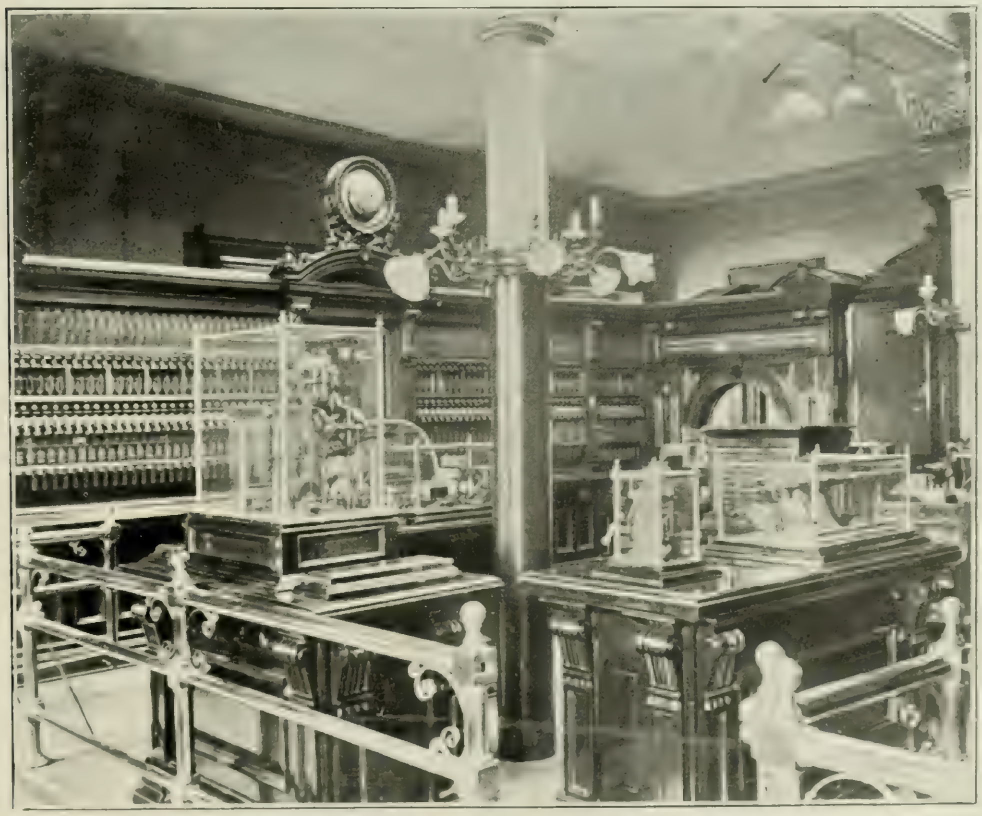


FIRE-ALARM BOX WITH INNER DOOR OPEN.

the central office the number indicated on the face of the box. This number is immediately re-transmitted from the central office by a repeating instrument, which transmits the signal over the various circuits to the companies which are to respond, as shown in the table on page 805.

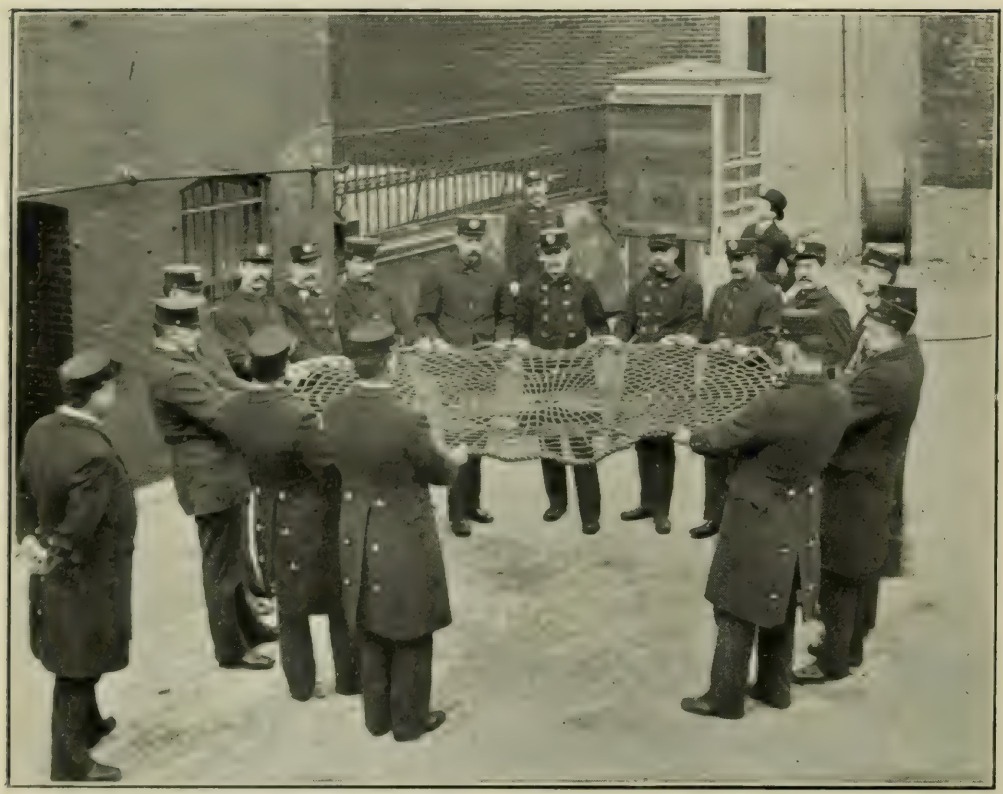
The inner box contains a Morse key, a small armature, and a small gong. The Morse key is used when additional help is required, after the arrival of the first company at the scene of a fire. The officer in charge, if, in his judgment, additional companies are required, directs the sending of a second alarm, which is sent by Morse key from the box to the central office, the signal 2–2 being followed, say, by Station 8 6, which indicates that all the companies on the second line for station 8 6 are to go to that station. Should still further help be required, a third alarm is sent, the signal 3–3 being followed by station 8 6. The 4–4 and 5–5 alarms are sent similarly. Then, if additional help is still required, the simultaneous call 9–9, station 8 6, 3–3,–3 7 9, is sent. This will bring all the companies assigned to the station at Broadway and Twenty-fifth street on the third alarm to Worth street and Broadway, and the same course may be pursued in any section of the city where the companies are still in quarters. Companies may also be called singly by the special call signal system. When all the companies are called by the fifth alarm for station 8 6 and are on duty, the city is still protected by reserve companies, as well as those moving to various quarters. For instance, the order E. 13 to E. 7, means that second section of Engine 13, at Wooster and Spring streets, shall proceed to quarters of Engine Company 7, at Chambers and Centre streets, and cover the ground left vacant by the absence of Engine Company 7 at the fire. The order H. 5 to H. 1, means that the second section of H. & L. Co. 5 shall go to the quarters of H. & L. Co. 1, Chambers and Centre streets, and cover the district left vacant. In this manner the outlying companies are gradually brought closer to the scene of large fires, so that, in the event of one or more fires at the same time, the city as a whole has protection by the use of the reserve sections, which, as a rule, are not used at the first fire, but are held in reserve.

In addition to the street boxes, there are a number of special boxes in public institutions, theatres, hotels, academies, colleges, and schools, which are in direct communication with the central office. An alarm from one of these boxes calls to the building two or more companies, and a chief officer. The central office is also connected by automatic signals, with a great number of mercantile houses. The law requires that public buildings, institutions, hotels, apartment-houses, colleges, etc., shall be connected with an alarm system in direct communication with the central office.



INTERIOR OF MAIN FIRE-TELEGRAPH OFFICE AT HEADQUARTERS, NEW YORK.

On the left, in the background, is the key-board, each key indicating a separate circuit, on which alarms are received. The smaller instruments on the centre tables are used for transmitting first alarms to the companies assigned for response to each box. The large instrument to the left is reserved for second, third, and special alarms. Opposite to the key-board is a switch-board, (not shown) by which the circuits are constantly tested.



MANNER OF USING THE LIFE NET.

The fire alarm system south of One Hundred and Tenth street, with few exceptions, is entirely underground, the department having for its use separate conduits in the underground system. From these conduits special lines are laid to the various boxes and engine-houses throughout the city, so that, in the event of a gale or severe snowstorm, the underground system can be relied upon in transmitting alarms.

The companies are assigned in the regular order of distance from their quarters to the locality indicated. If from any cause they should fail to arrive in such order, they are required, in forwarding their reports of operations to headquarters on the following morning, to state the cause of such failure, and also answer a set of questions. This is a record of the operations of the company, and is also a part of the records of the department. The action of every officer and man on duty at an alarm of fire is a matter of record, as well as the duties performed by the companies, and a copy is sent to the headquarters daily. The responsibility in all cases commences with the first officer arriving, who must assume command of the fire until the arrival of a superior, who in a like manner assumes command until relieved by some one higher in authority.

STATIONS.	Engine Cos.	H & L. Cos.	Deputy Chief of Depart.	Chief of Bat'al'n	Water Tower.	Company to Supply Fuel.	From Fuel Depot.	Companies to Change Locations.	RESERVE FORCE.		
									Engine Cos.	H. & L. Cos.	Ch'fs of Bat'al'n
84 * West Broadway and Worth St.	27, 31, 7	8, 1	L	2, 1	1	Eng. 27	No. 3	....	27, 31	15	4
	29, 12, 30, 13, 9	10	....	5	..	" 29	" 2	....	12, 10	6	6
	55, 6, 4, 32, 20, 24	20, 9	....	3	..	" 55	" 6	E. 33 to E. 7; H. 5 to H. 1	.....	..	..
	....	....	....	....	..	......	....	....	.....	..	..
	....	....	....	....	..	......	....	....	.....	..	..
85 * Church and Duane St.	7, 31, 27	1, 8	....	2, 1	1	Eng. 7	No. 3	....	31, 27	15	4
	29, 12, 6, 4	10	L	5	..	" 29	" 2	....	12, 10	6	6
	9, 13, 55, 32, 30	20	....	3	..	" 9	" 6	E. 33 to E. 7; H. 5 to H. 1	.....	..	..
	....	....	....	....	..	......	...	....	.....	..	..
	....	....	....	....	..	......	....	....	....	..	..
86 * Broadway and Thomas St.	31, 7, 12	1, 8	....	2, 1	1	Eng. 31	No. 2	....	31, 12	3	6
	27, 29, 9, 55, 4	10	L	3	..	" 27	" 3	....	27, 33	6	7
	6, 32, 13, 20, 33, 30	20	....	5	..	" 6	" 6	E. 13 to E. 7; H. 5 to H. 1	.....	..	..
	24, 17, 15, 10, 11, 25	9	....	4	..	......	....	E. 18 to E. 55; H. 18 to H. 20	.....	..	..
	18, 28, 5, 14, 3	5	....	....	..	......	....	E. 5 to E. 17; E. 16 to E. 14	.....	..	..
87 * Duane and Elm St.	7, 31, 12	1, 10	....	2, 1	1	Eng. 7	No. 2	....	31, 12	20	4
	27, 9, 55, 29	8	L	3	..	" 27	" 3	....	27, 10	15	6
	4, 32, 6, 20, 13	6	....	5	..	" 4	" 5	E. 33 to E. 7; H. 5 to H. 1	.....	..	..
	....	....	....	....	..	......	....	....	.....	..	..
	....	....	....	....	..	......	....	....	.....	..	..
88 * Centre near Pearl St.	7, 31, 12	1, 8	....	2, 1	1	Eng. 7	No. 2	....	31, 12	20	4
	9, 27, 55, 29	10	L	3	..	" 9	" 3	....	27, 13	15	6
	4, 32, 20, 6, 17	6	....	5	..	" 4	" 5	E. 33 to E. 7; H. 5 to H. 1	.....	..	..
	....	....	....	....	..	......	....	....	.....	..	..
	....	....	....	....	..	......	....	....	.....	..	..

TABLE ILLUSTRATING ASSIGNMENT OF COMPANIES, AND THEIR MOVEMENT ON FIRST AND LATER ALARMS.

The water is supplied by the reservoir system. Large conduits are run through the main avenues, and from these points distributed to the smaller mains throughout the city. To these smaller mains are connected the fire hydrants which supply the engines with water. The hydrants are of several patterns. Those that are now being set for use are of an improved type, and very seldom freeze, being connected to a sewer which permits the superfluous water from the barrel to pass into the sewer after the valve is closed from the main. Those of the old pattern freeze every winter, so that the engineers, on arriving with their engines, have to open the hydrant to see if it is frozen. If it is, the engineer immediately applies the thaw hose, connected to the boiler of the engine, and uses the steam and hot water from the boiler to thaw out the hydrant, which usually takes about five minutes. When the water is found, the connection is made, and the engine is ready to force water through the hose stretched from the engines to the fire. Many of the streets are still using the six-inch mains, which give a sufficient supply for an ordinary fire, but, when more than the usual number of companies are drawing water from this main, it is entirely inadequate. Many streets are supplied with mains from 12 to 48 inches in diameter, which obviate in a measure the defects of the smaller mains. In the districts where the larger pipes are located there is never a scarcity of water. Since the introduction of the new aqueduct, the supply has met every requirement, even at extraordinary fires.

Spare engines, with men, are detailed to thaw out all hydrants found frozen, and these hydrants are then salted, turning any water remaining in the barrel into a strong brine. This course is followed during each cold spell throughout the winter.

THE RELATION OF FORESTATION TO WATER-SUPPLY.

By Herbert M. Wilson.

ONE of the most striking and significant developments of recent years is the rapidly-increasing interest in meteorology and the growing appreciation of its important relations to a wide range of engineering work.

It is, of course, the study of rainfall and its distribution which is of the greatest evident and practical value. Upon this depend most of the problems of procurement and conservation of water-supply, with their wide range of relations to civil, municipal, domestic, and sanitary engineering. Equally intimate is the dependence of irrigation, the revivified science which many engineers consider the most progressively active branch of the profession at present, and irrigation is already exerting an influence in many departments of industry, of which transportation will not be the least. The whole problem of the flow of streams, and their control in the interests of commerce, manufacture, and the safety of the population resident on their banks, are based upon an accurate knowledge of rainfall over the catchment basin and the influence of topography and vegetation upon the precipitation and run-off.

When many of the largest cities are confronting the question of an enlargement or replacement of their water-supply ; when semi-arid western America is looking to the engineer to bring water in the midst of the desert ; when the river-cities of the United States are menaced by sudden flood ; when the present enormous traffic of the great lakes, and the future greater traffic, are studying the problem of adequate waterways through the lakes and to the sea ; when, lastly, the decadent importance of the water-powers of every land has been startlingly electrified to new and abounding life,—it becomes manifest that the study of our " water-revenue " and its maintenance has assumed importance for engineers in all divisions of the profession.

It is my purpose in this paper to discuss the general relations of forests to sources of water-supply. Three phases may be considered :

1. The effect of forests on the ultimate source of water-supply—precipitation.

2. The effect of forest-cover on the water-supply of springs and perennial streams by aiding or retarding percolation.

3. The effect of forest-cover on the intermittent or torrential flow of streams by retarding the rate of surface run-off.

Viewed from a purely sentimental standpoint, the first inclination of one who considers the relation of forests to rainfall is to believe that the cooling shade of forests and the greater amount of moisture in the soil beneath them and in the streams which run through them is due to a greater rainfall in the neighborhood. Few consider that the existence of forests, which require much water for their maturing, is probably due to the natural moisture of the localities in which they are found, as in arid countries their absence is due to the lack of sufficient water to sustain them. Dr. Brandis, of the meteorologic bureau of India, states that the heaviest known rainfall—that in Assam—occurs over one of the densest known forests, and adds: "But it is more probable that the forest exists because of the rainfall than *vice versa.*" There is a mass of literature which attempts to prove that this moist condition is produced by the forests, little of which is founded on anything more definite than bare assertions. There are on record no actual tabulated statistics showing the effects of forests on rainfall that can be made to sustain this theory.

All the experiments made in relation to this subject may be divided into two classes, which may be characterized as the retail and the wholesale methods. The retail method has been practised chiefly in Germany, its operations covering limited areas, consisting chiefly in the establishment of two meteorologic stations, one within the edge of the forest and the other at a fraction of a mile from the first and in the open. A careful study of the data shows that the amount of rainfall in the forest is so slightly in excess of that in the open as to be of little economic importance, and no greater than might be due to accidental differences in topography or climate. One must, however, use the greatest care in drawing conclusions from this class of observations, for, as shown by Prof. Cleveland Abbe, the influence of wind on the catch of rain gages is sufficiently great to materially affect the results of such observations. He shows that high gages in forests should catch more rain than low gages in the open because of these effects, and sums up by stating that "the results of certain observations made by Blanford in India serve to dissipate the last argument in favor of the idea that forests appreciably increase the rainfall as distinguished from the catch of the rain gage."

Mr. Henry Blanford, in a report of the meteorological bureau of India, publishes a short series of observations of rainfall at a couple of pairs of stations on the margin of forests in Dehra Dun and Ajmere, India, in 1884-5. Two pairs of stations were established in each place. Rain gages were placed a few hundred yards from the edge of the forest in the open country and at a like distance within the forest. The distance between the stations was about half a mile. Summarized, the observations show that in 1884 the average rainfall at the outer station was 69.97, and at the inner station 70.68 inches. In 1885 the average rainfall at the outer station was 84.57, and at the inner station 86.13. These observations show a very slight excess of rainfall at the inner station,—not quite one inch in 1884 and a little more than one and one-half inches in 1885. The distance between these stations was so slight that it seems scarcely possible to believe that the difference in rainfall was the result of any permanent or general effect which the forest may have had on the climate. It is not unlikely that the differences shown by these observations are due to wind currents about the rain gage in the forest. Much greater differences have been recorded at the same point by two rain gages so placed that one or the other was peculiarly affected by wind currents, or by the distance of the mouth of the gage from the surface of the ground.

Dr. A. Woeikoff made rainfall observations at three stations in the neighborhood of Nancy. Station *A* was within the forest; *B* on the edge of the forest, and 430 feet lower than either of the others; *C* within the open fields, a short distance beyond station *B*, and at the same elevation as station *A*. The total rainfall shown by seven years' observations is 76.7 centimeters at station *A*, 69.3 centimeters at *B*, and 64.9 centimeters at *C*. Here is shown a moderate increase in rainfall in the forest.

It will probably never be possible to conduct an extended series of rainfall observations within a large forest area and within a large area of open land near it which will show definitely the effect, if any, of forests on precipitation. The variations known to exist in the amount of precipitation between two stations not very distant which are placed under identical topographical conditions, and both within forests or both without forests, are quite as great as any which we are as yet able to show between two stations placed one in the forest and the other out of the forest.

The wholesale method of studying the relation of forests to rainfall consists in a comparison of rainfall data obtained before and after deforestation or reforestation has taken place over great areas of country. Such comparisons have been made in many countries, as France, India, New South Wales, and the United States. Another form of the wholesale method is that of the comparison of the climates of two adjacent regions, one forest-covered, the other barren. It is unnecessary to discuss this method, since a description of it is sufficient to condemn it. It is absurd to compare two separate regions with a view to determining forest influences upon them, when naturally their climates may differ greatly with or without forest-cover.

Continued observations of rainfall in the western United States, conducted over portions of the treeless plains in the early days of settlement and since tree-planting has become common, show no appreciable difference in rainfall. It is well known that the cultivable area has moved steadily westward, but this is not a result of increased precipitation, but of better methods of husbanding the moisture of the soil through sheltering it from the dry winds by means of windbreaks and through making it more retentive of what moisture falls on it by ploughing and by more intelligent methods of cultivation.

In the eastern portion of the United States some attempts have been made to determine the effect of forest destruction on rainfall. Mr. Thomas P. Roberts, an eminent civil engineer, made a report of official rain-gage observations at thirty-seven stations for the decade 1870-80. Considering them by halves, the second half shows an increase of 1.68 per cent. of rainfall per annum over the first, though deforestation had been constantly increasing during that period. In all of the Michigan and Wisconsin stations more rainfall was reported in the last half of the decade. In like manner he combined the rain-gage records at Pittsburg, Pa., and Cannonsburg, a town near Pittsburg, for a period of thirty-nine years, and divided these observations into two nearly equal periods, the second half of which shows an average increase over the first of 2.67 inches per annum. Likewise, the increase of rainfall at the city of Philadelphia between 1810 and 1875 has been almost uniformly progressive from 32.67 to 43.35 inches. The above figures appear to indicate an increase in the rainfall with the settlement of the country. These and similar data covering extensive regions in the eastern United States which have been deforested within the past forty years indicate an increase rather than a decrease in rainfall during that period. This may possibly be due to settlement, but records made by gages twenty or fifty years ago must be used with caution, as modern gages are better made and placed, and give larger measures than the old ones.

The most positive evidence that has been gathered to show the effect of forests on precipitation is the result of a study of rainfall observations made by Mr. Blanford in the central provinces of India. It appears that a method of cultivation had been employed there by the wild tribes, which consisted in burning off a bit of forest land and cultivating it for a year or two. At the end of that time the native would move to other localities and burn off a new clearing, only to abandon it again after a year or two of cultivation. The government concluded as a result that deforestation was taking place at too rapid a rate, and accordingly instituted a system of forest protection. During the next ten years forest growth was encouraged over much of this area, and rainfall observations were conducted simultaneously. Comparisons of observations made for ten years prior to the inception of forest protection, from 1867 to 1875, and for ten years succeeding forest protection, from 1876 to 1885, show an average uniform increase in rainfall in fourteen provinces examined of 6.8 inches. Mr. Blanford says, however, that the error of rainfall observations in the central provinces is five per cent. plus or minus, and that this error might readily account for the differences shown. A study of the progressive increase, if such exist, would tend to show whether the errors in observations were the cause of the total increase of 6.8 inches. An examination of the yearly rainfall statistics proves that there was a progressive increase from 1876, the time of beginning forest protection, and that this increase was about proportional to the tenth of 6.8 inches. The average annual rainfall increased almost uniformly from 49.50 in 1876 to 58.57 in 1883,—an increase of about 20 per cent.,—while the progressive average of rainfall for the rest of the central provinces increased scarcely at all,—from about 40.5 in 1876 to 43.1 in 1883, this increase being due to the general increased rainfall of the latter year evident all over India. It would be difficult to deny the very positive evidence of forest influence on rainfall shown by these figures, were it not for the fact that, since the publication of these data, it has been asserted by Mr. Blanford and other Indian meteorologists that the observations were erroneous.

A careful study of all the statistics obtainable in Europe or in this country bearing on rainfall and the relations of forests thereto fails to indicate positive evidence of appreciable effect on the amount of precipitation by the destruction of forests. Mr. Henry Blanford perhaps sums up as well as could be all that might be said on this subject in his remark: "The difficulty is to disentangle the combined effects of numbers of causes all favoring increased rainfall or the reverse. This renders it a hopeless task to seek for decisive evidence of the influence of forests on rainfall."

Another remark of Mr. Blanford leads to the second division of our subject. He states that "forests protect the soil, and help to keep up the constant evaporation, thus enhancing the rainfall." Of what value is it to enhance the rainfall, if at the expense of water taken from the soil and transpired through the leaves? Moreover, the forests prevent much of the rain which falls upon them from reaching the ground, thus neutralizing their supposed beneficial influences. The usual claim is that forests diminish the amount of evaporation by reducing the temperature beneath their shade and diminishing the force of the wind.

All vegetation imbibes a certain amount of water, a small part of which is consumed in building up its body, a much larger portion being returned to the atmosphere by transpiration during the process of growth. Experiments conducted in Austria by F. B. Hoehnel show that during the period of vegetation the following trees transpire, in pounds of water per pound of dry leaves, as follows :

Birch and linden	600 to 700 pounds.
Ash	500 to 600 "
Beech	450 to 500 "
Maple	400 to 450 "
Oak	200 to 300 "
Spruce	50 to 70 "
Fir	30 to 40 "
Black pine	30 to 40 "

The variability of the transpiration from day to day is of wide range. A birch standing in the open and found to have two hundred thousand leaves was calculated to have transpired on hot summer days 700 to 900 pounds of water, while on other days its transpiration was probably not more than 18 to 20 pounds. A fifty-year-old beech transpires at the rate of about 400 pounds of water per pound of dry leaves during vegetation, which would make the total transpiration of the tree 3,944 pounds, or at the rate of about 22 pounds of water per day. If 500 trees stand on one acre, the transpiration per acre amounts to 1,972,000 pounds, while the precipitation during the same period would perhaps be 2,700,000 pounds. It accordingly appears that deciduous trees transpire about as much water per annum as is equivalent to a rainfall of ten inches.

It is generally argued that this water has been given back to the atmosphere in the locality in which it fell, thus enriching the atmospheric moisture. It would be absurd, however, to assume that this moisture, after being returned to the atmosphere, simply hovers as clouds over, and is redeposited again on, the place from which it was evaporated. It is caught up by the winds and carried about, some of it falling on cleared lands and some on forests, so that, carrying this line of argument to its logical conclusion, nearly half as much water again should fall on the cleared land as on the forest, since half of what falls on the forest is evaporated to ultimately find its rest on cleared fields, the area of forest and cleared land being assumed to be equal. The soil evaporation beneath dense forest shade is about 40 to 50 per cent. of the evaporation in the open. The trees transpire an amount equal to ten inches in depth. Assuming the average evaporation of a region to be 36 inches in the open, the evaporation of forest soil would be about half of this, or 18 inches, and the evaporation from the trees 10 inches more ; that is, the evaporation in the open would exceed that in the forest by 8 inches.

Experiments show that forests diminish the amount of precipitation which reaches the soil by preventing its falling to the ground. It is well known that in light showers the foliage of the trees protects the ground beneath from being wetted, and we have all seen the circle of dry soil beneath the shade of trees after a light shower which has perceptibly moistened the ground about. It is well known that the water which is thus intercepted by the leaves is returned to the atmosphere by evaporation. According to Vaillant, the amount of waste by the foliage in the forest of Fontainebleau amounted to nearly 40 per cent. of the fall. Experiments by M. Mathieu showed, however, a somewhat less amount of water intercepted and re-evaporated from the leaves of trees. Careful measurements at Swiss stations for an average of twelve years show the interception in a larch forest to be about 15 per cent. and in a spruce forest 23 per cent., while Prussian observations show for beech growth an interception of 24 per cent. Altogether, a dense growth will, on an average, intercept about 23 per cent. of the precipitation. Returning to our former example, if the precipitation were 40 inches, the forests would intercept about 9 inches, and, as the evaporation was about 8 inches in favor of the forests, the balance indicates that less water remains on the soil in forests than in the open.

There is still to be considered another effect of forest-cover on water of percolation. It is popularly believed that litter, the result of decaying leaves, moss, etc., which covers the soil in forests, performs a conservative function, increasing the flow of springs. Mr. B. E. Fernow says that this idea is entirely erroneous and in contradiction to physical laws. He says: "Water filters through the soil-cover by the law of gravitation, until the spongy mass has become fully saturated. If the supply of water continues, it will filter through to the soil and some of it will be absorbed, but the cover will refuse to convey and will shed much of it superficially, leaving opportunity for the water to reach the soil only where the covering of litter is interrupted. The rain having ceased, evaporation begins, and capillary attraction supplies the cover with its loss on the surface from the soil below." Accepting this as true, it appears that the soil cover in forests tends to diminish rather than increase the amount of water entering the soil. Mr. Fernow sums up by saying: "It is, then, the protection against evaporation alone, due to the greater relative humidity of the forest and the shade, the breaking of the winds, and the protective soil-cover, which makes the forest a conservator of moisture. . . . The total conservative effect of the forest is expressed by the difference between the elements of dissipation and conservation ; the former comprised in the loss of water by retention, interception, evaporation, and transpiration ; the latter in the protection against evaporation. The balance is known to be in favor of the forest-cover.''

The evidence does not show that the balance is in favor of forest-cover. If the only conservative effect of forests is a protection against evaporation, then it will be conceded, from what has already been shown, that the difference of evaporation in and out of forests is less than the increased losses within the forests due to the causes cited.

Let us now look at this subject from the last, and perhaps the most important, point of view,—that of the effect of forest on the run-off or surface-flow. It is probable that soil-cover has an influence on the physical conditions of the soil by increasing filtration, because it tends to preserve the granular, porous structure of the soil beneath the litter, thus affording channels for unimpeded drainage. Unless soil cover has a tendency to retard penetration, the influence of the forest upon absorption would be to diminish surface-flow and to increase subterranean drainage ; but the same effect would be produced in some degree by all forms of vegetation and cultivation. The nature of the soil and its cover have an infinitely less effect upon the run-off than have the topography, geology, and atmospheric conditions. There can be no question that, between forest-covered, cultivated, or sodded soil on steep slopes, the relative differences in run-off are so slight as to be practically inappreciable. It is also well known that trifling changes in temperature or in wind-velocity have a far greater effect on evaporation, and the consequent amount of percolation, than has forest-shade. In rough country, such as the Adirondack region or the mountains of Tennessee or West Virginia, or of the far western United States, the slopes of the water-sheds are so steep that, in spite of the forest-cover, a trifling rainfall will induce a rapid rise of the streams, though the same amount of precipitation would scarcely wet the ground in more level country. The effect of these factors on run-off is so great, relative to any possible conservative effect which forests may have, as to render the latter scarcely worthy of consideration in this connection. As an instance of the great effect of temperature and wind upon water conservancy, we all know of the enormous and rapid floods produced by a warm rain or wind on snow-covered ground.

Careful observations were made on the river Seine in France by M. Belgrand on two forest areas of equal size, one of which was half cleared, but the observations showed no perceptible difference in their discharges. M. Lemoine, who has been investigating this subject for years in France, says : ''The action of forests along the Seine had no influence upon the flow of streams as compared with the action of ground covered with grass.'' He says that the only absolutely certain influence of forests on water flow is that it prevents the soil from being carried away by water; in some portions of the Hautes Alpes forests have been replanted with a view to retarding the formation of torrents, or extinguishing torrents already formed, but, he adds, "in most cases turfing alone has produced the same effect.'' Mr. Russell, as a result of careful observations, says: "Bushes or forests protect the soil from being scored by ravines, but do not seem to affect the regimen of streams, excepting where the soil is left barren.''

Numerous statements emanating from mill-owners or farmers have been published, and are used as an argument in favor of the protection which forest-cover affords against floods. These are all to the general effect that certain mills in years gone by received a water-supply, but that in recent years, since timber has been cut above them, these mills have not been running. None of these statements are well authenticated, and there is little to show that the streams which supplied these mills were not as erratic before as after the removal of the forest growth. It can not be denied that such effects appear to have followed the wholesale and wanton destruction of forests. There is no proof, however, that deforestation has any appreciable effect on rainfall, while the old regimen of the streams is practically restored after the cultivation of the deforested area, or after brush or second-growth timber appears. In many of the mountains of the arid western United States, where great forest areas have been burned over, it not infrequently happens that floods wash the soil away before a new growth appears. Then it takes many years, owing to the infrequency of rain, to secure a new growth of trees or brush.

Some years ago Mr. Gustav Wex, an Austrian engineer, published a pamphlet discussing the relations of forests to the flow of European rivers, and attempted to show that deforestation had been unfavorable and reforestation favorable to stream-flow. Mr. T. P. Roberts discussed Mr. Wex's pamphlet in a paper before the American Forestry Association in 1885, and showed, by a proper use of Mr. Wex's data, that it is entirely inconclusive. Discussing American rivers, particularly those at the head of the Ohio and Monongahela rivers, Mr. Roberts shows that conservation of rainfall in local districts is not aided by forests. He also showed that, while deforestation had been going on for some years on the basins of certain American rivers, no appreciable change in their regimen or annual flow had resulted. In fact, as a result of his observations, and those of Mr. Abbott, in New South Wales, and of others, it would appear that, if deforestation had any effect on the run-off of large streams, it was rather to make their regimen more regular than otherwise. For it is improbable that it would be conducted uniformly over the entire catchment basin of a great stream, and the removal of forests from certain branches only would have the effect, if it left the soil bare, of allowing the water from these branches to reach the main stream a little ahead of the time at which the water from forest-clad.branches would reach it, and thus would have a tendency to equalize its flow by extending it over a longer period of time. Stream gagings made in the United States by officers of the United States engineer corps, the United States geological survey, and others, do not show any effect on the flow of the streams by the cutting of forests. The regimen of streams varies so greatly from natural causes, and the curves of discharge vary so greatly for periods of years, or months, or even days, as to obliterate any possible effect which the removal or replacement of forests might have.

The facts here brought together do not depend for their authenticity on the haphazard opinions of those who "think" the regimen of streams is changing in deforested regions,—opinions founded on the recollections of individuals as to the apparent discharges of streams during their childhood. We all know how much credence to give the "oldest inhabitant's" opinion that the "seasons are changing," or that "there never was so early or so late a frost." On the contrary, the materials on which this article are founded are careful investigations and experiments by trained scientific experts.

Authentic and recorded observations cannot be made to show that deforestation has had any effect of economic importance upon. the run-off of flood waters, the regimen of streams, or the flow of springs. To sum up further, the same causes have likewise produced no effect of economic importance upon the amount of precipitation. Deforestation, except on very steep mountain slopes, rarely leaves the soil barren. It is usually followed by cultivation or the springing up of brush or other wood growth, and experiments show that all forms of soil cover have nearly as great an average retarding effect on run-off, and as much influence on percolation, as has forest-cover.

Finally, while there is no positive evidence that forests have a beneficial influence on precipitation, or any greater effect on the flow of springs or the rate of run-off than other forms of vegetation, there remains a slight chance that it may influence the last two processes. Accordingly, while there consequently appears no good reason, so far as water-supply is concerned, for refraining from the cutting of woods over regions thereafter to be devoted to agriculture, there is a slight reason for preserving forest-covers on such mountain slopes as are too steep for after cultivation, lest they be washed bare of soil and their influence on run-off and spring supplies be seriously affected.

THE HOT-WATER SYSTEM FOR THE HEATING OF BUILDINGS.

By J. J. Blackmore.

THE subject of this article is far more important than the average architect and builder has been willing to admit in his provisions for the comfort of the occupants of the modern residence, though the writer has observed in some instances a full appreciation of the advantages of hot-water heating.

Before examining the appliances used and the different methods of construction, I will describe the apparatus and its points of advantage, taking for illustration a complete plant arranged for a small house heated by direct radiation, according to the two-pipe system (see Fig. 1).

The heater, being the heart of the plant, is placed in some convenient position in the cellar of the house, and feed-pipes are run from the top of the heater to the radiators in the rooms. Each radiator has also a return-pipe, which is carried back to and connected at the bottom of the heater.

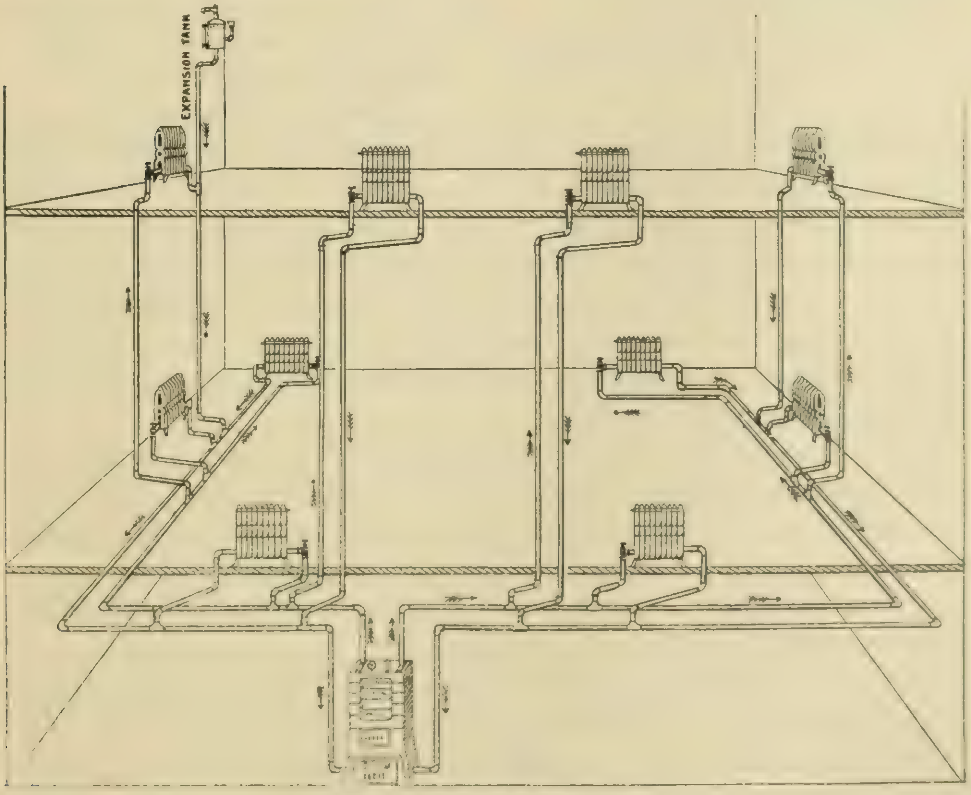


FIG. 1. TWO-PIPE SYSTEM.

A tank is placed in a convenient position above the highest radiator, and the bottom of this tank is connected to the return pipe of one of the radiators, or to the bottom of the heater, as may be most convenient. From the top of this tank a relief-pipe is taken to the roof, or to some other place where the water can escape, should the apparatus, at any time, become overheated.

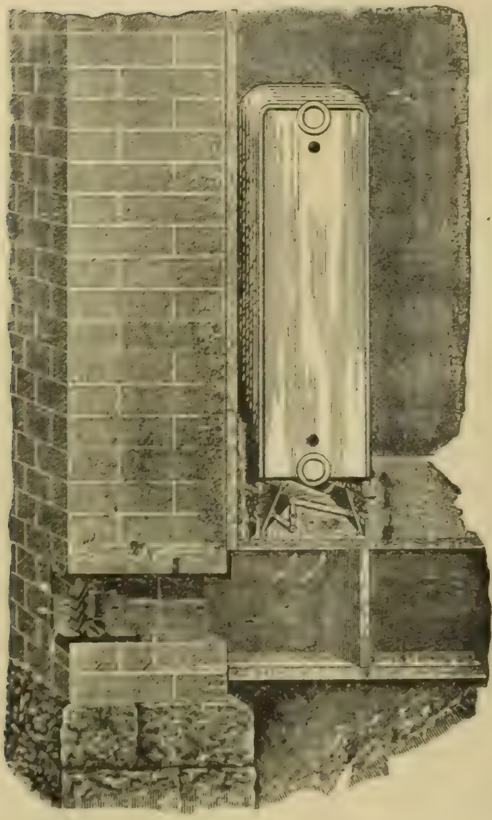


FIG. 2. SEMI-DIRECT SYSTEM, OPEN RADIATOR.

Semi-direct radiation differs from direct only in the introduction of fresh air, through the radiator, from the outside, as shown in Fig. 2. The radiator, in this case, has a closed base, and a damper to regulate the flow of air. This method is adopted to supply fresh air for ventilation, and is used largely in schools, hospitals, etc.

Where radiators in rooms are objectionable, or where a large volume of fresh air is needed, the indirect method of heating must be resorted to ; in such cases the radiator is hung to the ceiling of the cellar, immediately below the room to be heated, and is enclosed in a chamber of tin-lined wood or galvanized iron. This chamber must be made to fit tightly to the radiator at the sides and ends, but a large space must be left at the bottom to receive the cold air, and a similar space at the top from which to distribute the warm air.

For this purpose special radiators are made in many forms, all, however, using the same method of circulating the air. The fresh air is taken from the outside into the lower chamber, and is passed through the spaces between the sections of the radiator to the upper, or warm-air, chamber, from which a pipe, or flue, leads to the register in the room to be heated (see Fig. 3).

When the semi-direct, or indirect, system is used, it is necessary to have some means of removing the foul air from the rooms in order to make way for the fresh air supplied through the register. In private residences this can be accomplished by the ordinary fireplace flue,

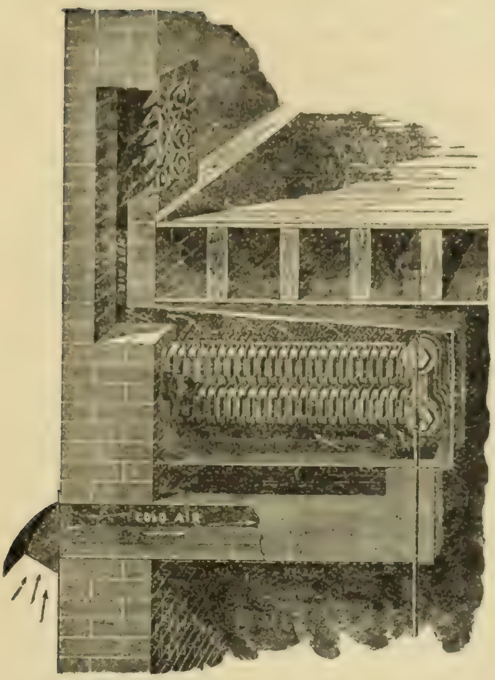


FIG. 3. INDIRECT SYSTEM, CONCEALED RADIATOR.

but in large buildings regular ventilating flues should be provided.

When the apparatus is connected and ready to be filled, water is let into the system till it reaches the gage glass in the expansion tank. The operation is aided by letting the air escape from the air valve in the top of each radiator. When the apparatus shows about four inches in the glass of the tank, the water should be shut off. Then the apparatus is ready for use.

As soon as a fire is started in the heater, the circulation in the pipes and radiators begins, the warm water from the heater rising, and the cooler water in the radiators falling back, according to the laws of gravitation. The extra bulk of the water caused by the heat is held in the expansion tank.

One of the great advantages of this system is the wide range of temperature for which it can be adjusted. The temperature of the water may be as low as 100 degrees or as high as 210 degrees without waste.

In the climate of the northern United States it is necessary to provide for temperatures ranging from 60 degrees above zero to 40 degrees below. Therefore a system which will provide a range of temperature greater than that required by such a climate must be a very suitable medium for distributing artificial heat for personal comfort.

To illustrate this point more fully, I will assume that the apparatus is designed to meet the extreme condition mentioned,—*i.e.*, 40 degrees below zero,—and that the radiators are large enough to give all the heat necessary with the water at 210 degrees in the apparatus. Having these conditions in mind, it will be seen that, if the weather moderates to 20 degrees below zero, the water will need to be heated only to 190 degrees to give the required heat in the house; at zero 170 degrees will be sufficient, and at the freezing-point of water 150 degrees in the apparatus will warm the house to 70 degrees. The only adjustment needed is in the firing.

On the heater should be placed a thermometer to indicate the temperature of the water in the apparatus. An altitude gage is also useful to indicate at the heater the height of water in the tank.

Thermostatic regulators can now be purchased, which materially add to the ease of management of such an apparatus. They can be arranged to close the draft dampers on the heater, if the temperature rises above 70 degrees in the rooms, and to open them if the thermometer falls below 70 degrees, thus keeping the house at a uniform temperature so long as the fire has attention. A well-designed appatus should not need attention oftener than four times a day in severe weather, and twice a day in ordinary winter weather.

In these days of severe competition, there are plenty of manufactured goods to choose from, and hot-water heaters are no exception to the rule; they are made in almost every form into which cast iron, wrought iron, or steel can be moulded or bent.

One important feature much overlooked by manufacturers in the construction of heaters is the low temperature of the water passing through them, and the difficulty of combustion under such conditions. In many heaters now in use the fire-box is so hedged and covered by comparatively cool surfaces that there is not sufficient room for proper combustion to take place, and a large portion of the fuel, in the form of unconsumed gases, goes up the chimney with the smoke.

Another defect is the excessive amount of grate surface in many heaters, compared with the amount of heat-absorbing surface that is placed above the fire. Very few makers of heaters state the quantity of fire surface in their heaters; most of them are content with stating the size of the grate and the quantity of radiating surface which the heater is capable of taking care of. This rating varies so much that it is very misleading, and the resultant mistakes have often been the cause of a failure, or partial failure, to give the good results which would have been secured if the full details of measurement or a more conservative rating had been given.

A good proportion of grate surface to heating surface for a hot-water heater is one foot of grate to eighteen feet of fire surface, in small heaters, and one to twenty-five in larger sizes. The proportion of fire surface in the heater to the radiating surface in the system should be one to eight, or one to ten, for the smaller sizes, and, for the larger sizes, one to twelve, or one to thirteen. These proportions may be changed by a more rapid rate of combustion, but this means closer attention to the fires and greater consumption of fuel.

The best forms of heaters are those of the water-tube type, the fuel gases being cooled much more quickly in the fire tube, on account of being separated and surrounded by cool surfaces, while in the water tube type the water is separated and the gases kept together, allowing a much better combustion of the gases. Some water-heaters are so peculiarly constructed that it is difficult to state in which class they belong, but the above remarks will enable the reader to more readily appreciate the merits of any heater he may choose to examine.

Two features of great importance must be kept in mind. Heaters must be arranged so that the fuel can be thoroughly burned, and the surfaces must be presented to the fire so as best to absorb the heat from the fuel.

It does not make any material difference how the heater is put together or what is its shape, so long as its construction is durable and properly arranged for cleaning and for the circulation of the water.

Many engineers and some manufacturers contend that the vertical section is preferable to the horizontal, but this depends a good deal on the shape of the section. My experience slightly favors the horizontal type, for the reason that the friction offered by this form is of benefit to the water circulating through it. The friction, however, in many heaters of this class, is so great as to offset any advantage the form may otherwise possess. Too much friction in a heater retards the circulation, and allows steam to form, causing trouble and injury to the working of the apparatus. On the other hand, the reason why a certain amount of friction is advantageous is that the water, in circulating through the system, gathers an impetus, due to its weight, similar to the momentum accumulated by the fly-wheel of an engine as its revolutions are increased. This impetus is sufficient to carry a certain portion of water through the heater without taking up heat, unless some friction is offered to divert the water over the hotter portions of the fire. If this is done carefully, the heater can be kept, in all its parts, at a uniform temperature, and very little wear is occasioned by expansion. If the friction is unduly increased, the circulation of the water is retarded, and steam is generated; this allows parts of the heater to become overheated, and, in cast-iron heaters, will often cause the

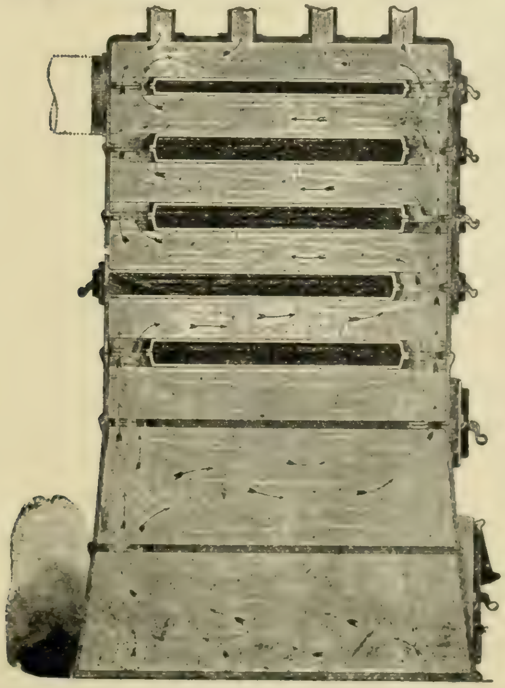


FIG. 4. HEATER WITH POSITIVE CIRCULATION.

section to crack, or at least will cause a very annoying water-hammer.

In Fig. 4 is shown a section of a heater with a positive circulation, and yet of such a form that but little friction is offered to the movement of the water. In Fig. 5 is shown a section of a common form of heater, which offers too much resistance to the flow of the water through it; in all such heaters steam is very apt to form before the water can get through, especially if a strong fire is kept in the heater. Fig. 6 also shows a common form of heater without any provision for circulation; an examination of this will show at once that, if there is any impetus to the water when it enters the bottom of the heater, it will pass through the easiest passage, which is at the outside of the section and away from the fire. Some engineers contend that no impetus is gathered by the water in circulation, but this assumption is easily disproved by a little calculation. Let us take as an illustration a radiator containing one hundred feet of surface. Let us assume that each foot of this radiator gives off 175 units of heat for each square foot of surface per hour, or a total of 17,500 units per hour, and that the difference in temperature between the flow and return pipes is ten degrees,—equal to the passage of 1,750 pounds of water to and from the radiator per hour. As radiators of this size are usually fed by a 1¼-inch pipe, this means a velocity of about fifty-five feet per minute. As an ordinary apparatus contains from one and a half to two tons of water moving at a velocity of fifty-five feet per minute, the force gathered is considerable.

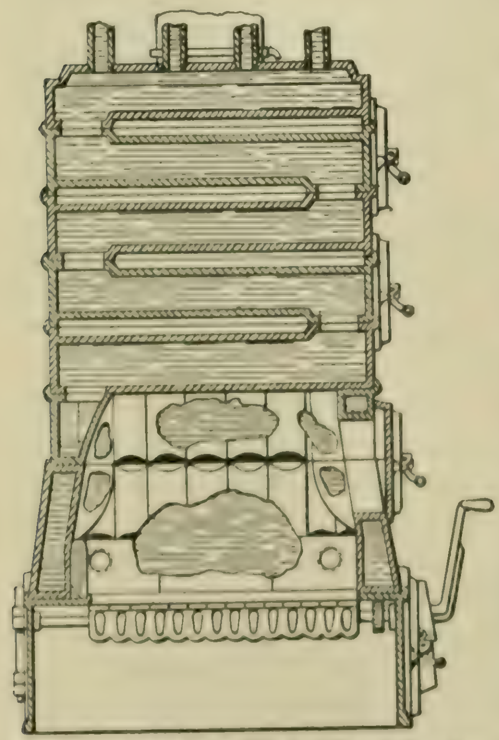


FIG. 5. HEATER WITH RETARDED CIRCULATION.

The success of a hot-water heating apparatus will depend very largely on the skill with which the flow and return pipes are put in place. Three requirements are essential to success. The pipes must be properly proportioned and properly graded, and must be put up with as few sharp bends as possible.

In proportioning the flow and return pipes, the laws of hydraulics must be carefully considered, especially in relation to friction on the water flowing through the pipes. The friction is much greater on the small pipes than on the larger sizes.

Various rules have been suggested for proportioning the size of main flow and return pipes, but none of them are entirely satisfactory to me. Those based on the velocity of water due to the height of a column are misleading, because of the great variation in the heights of buildings.

I have devised a rule by taking into consideration the average head, the friction, and the velocity of flow necessary to supply the lost heat.

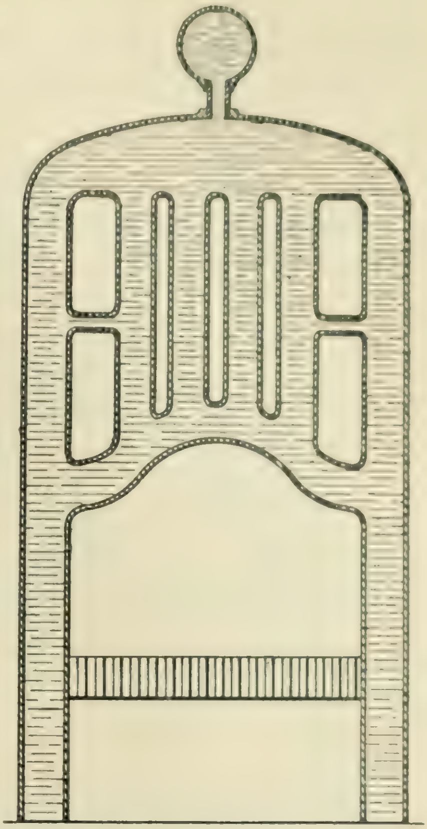


FIG 6. HEATER WITH UNCHECKED CIRCULATION.

I take as a basis for calculation a radiator containing 100 feet of surface. Such a radiator loses about 175 units of heat per square foot per hour, when working at a temperature of 185 degrees, and, assuming that to be the required amount, this is equal to 17,500 units per hour. As the water, in circulating, will lose ten degrees, this means 1,750 pounds of water per hour, which, if fed through a 1½-inch pipe, attains a velocity of about thirty-five feet per minute, or, if fed through a 1¼-inch pipe, attains a velocity of fifty-five feet per minute, and, if fed through a 1-inch pipe, a velocity of eighty-five feet per minute. The 1½-inch pipe requires a head nearly four feet high, the 1¼-inch pipe a head of nine feet, and the 1-inch pipe a head of nineteen feet.

On the ground-floor of a building it is always possible to get a head of four feet, but not always a head of nine feet. It seems from this that the ratio of the area in a main for 100 feet of surface in a horizontal pipe is the area of a 1½-inch pipe. We should add to this something for friction, which, on one hundred feet of pipe and a number of elbows, will be considerable. If we increase the area one-fifth on this account, we have 2.13 inches of area as necessary to supply one hundred feet of surface under ordinary conditions. Probably a more exact figure is 2.10, which is what we get if we divide the diameter of the pipe into the ratio of its circumference. Now, as the ratio of the circumference to the diameter represents also the ratio of the friction on its contents, this ratio may be used as a constant, and we get the following simple rule for the area in inches required in a pipe for each one hundred feet of surface in a heating plant:

$$r = \frac{3.1416}{d}$$

in which r is the ratio and d the diameter of the pipe. From this formula we make up the following table:

Size of Pipe.	Ratio per 100 Feet of Surface.	Area of Pipe.	Quantity of Surface this size will supply.
1½″	2.10	1.767	84
2″	1.57	3.141	200
2½	1.25	4.908	400
3″	1.04	7.068	700
3½	.90	9.621	1062
4″	.78	12.566	1590
4½	.70	15.904	2272
5″	.63	19.635	3120
6″	.52	28.274	5440
7″	.45	38.484	8550

If the pipes are extended beyond one hundred feet, the friction will be fully provided for, if we use the ratio for one size smaller for each one hundred feet that the mains are extended. Thus, if a main is 200 feet long, use the ratio for a 4-inch pipe in place of the 4½-inch, and for 300 feet use the ratio for 3½ in place of 4½, and so on. The foregoing table is for horizontal main and distributing branches, and is not to be applied to rising pipes.

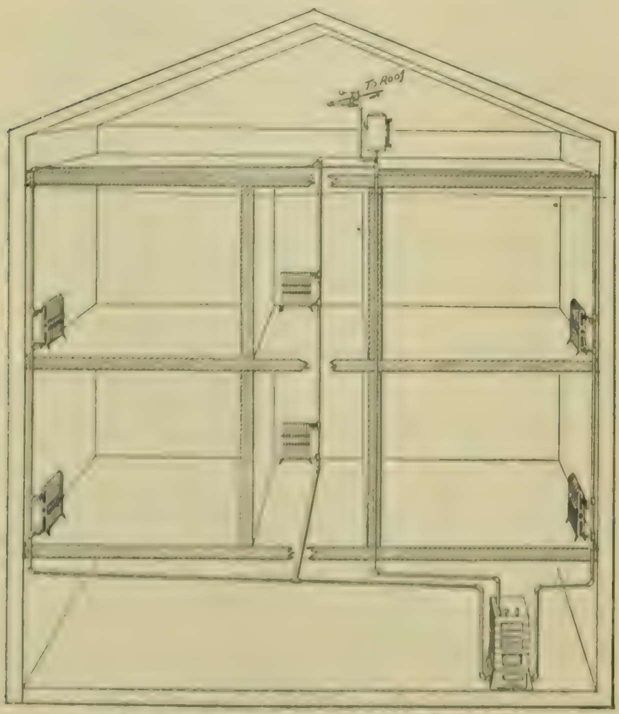


FIG. 7. SINGLE-PIPE RISER SYSTEM.

We have shown that the hot water necessary to supply one hundred feet of surface can be sent through a 1¼-inch pipe with a head of nine

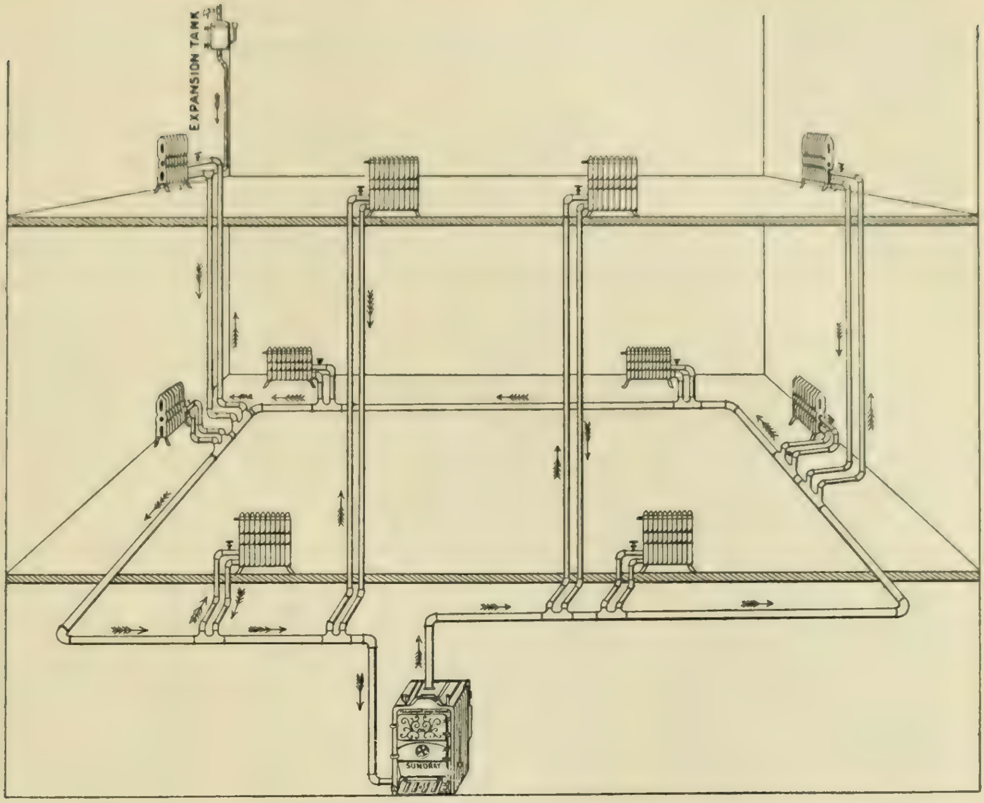


FIG. 8. SINGLE MAIN-PIPE SYSTEM.

feet, and through a 1-inch pipe with a head of nineteen feet. This shows clearly that we can supply such a radiator on the second floor with a 1¼-inch pipe, and on the third floor with a 1-inch pipe; the higher the building, the more the radiation that can be supplied with a given size of pipe.

Fig. 1 illustrates the two-pipe system. Fig. 7 shows a top-feed single-pipe riser system which is very largely used, and gives very satisfactory results. It is almost always resorted to in houses or other buildings having only low cellars or no cellars at all. It is also resorted to for heating radiators placed on the same floor or level on which the heater is placed.

Figure 8 shows the "single main-pipe" system, and is coming rapidly into use, being more neat in appearance and more durable, as well as losing less by friction and radiation than any of the other methods.

The rising pipes are the same as in the regular two-pipe system, the feed pipe being taken from the top of the pipe and the return back into the side; or, by a patent fitting now on the market, both pipes may be taken off the top, as the return opening in the fitting is passed to the under side by a shield.

It cannot be said that anyone of these systems is the best for all buildings, but it is easy for the engineer to determine which is the best for the case in hand.

Radiators are now made in so many different forms that it is impossible to consider them in detail, but we will deal with the different types, and endeavor to explain their relative merits.

A single-loop radiator, or a pipe coil, is more effective per square foot of surface than is a two-loop radiator. The two-loop is more efficient than a three-loop, and a three-loop is better than a four-loop.

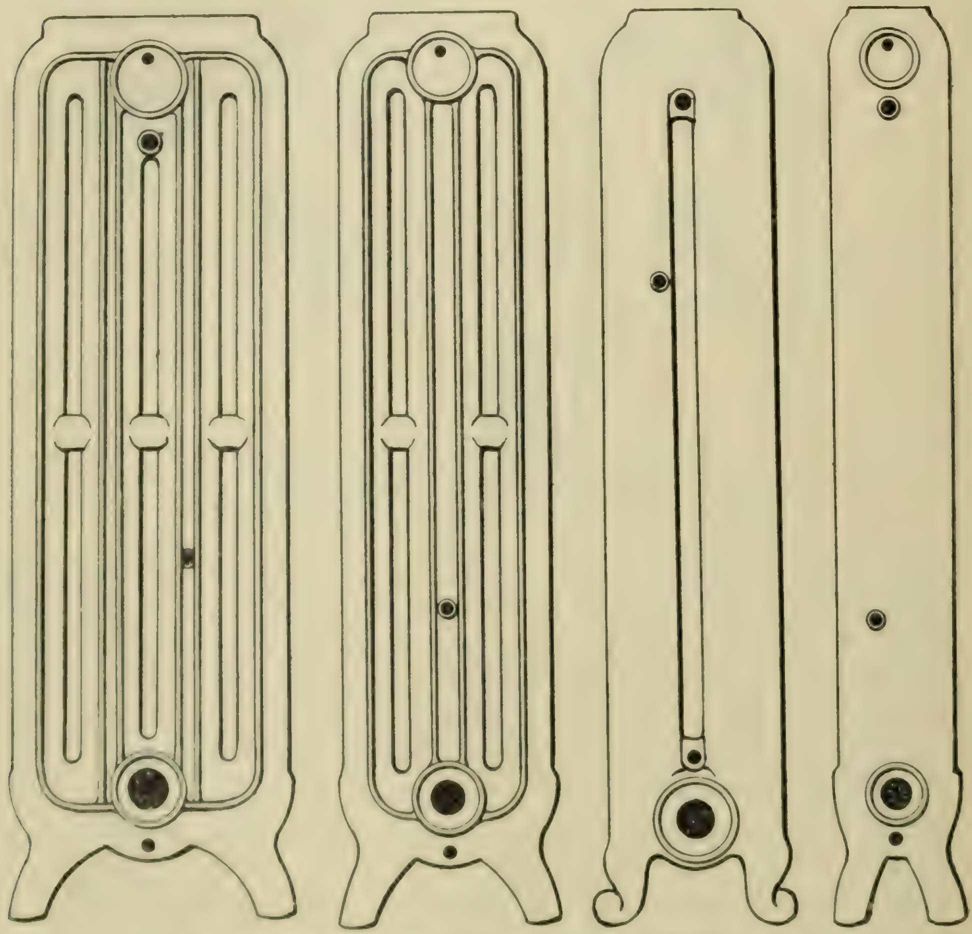


FIG. 9. SINGLE- AND MULTIPLE-LOOP RADIATORS.

The single loop, or coil, is the best form, for the reason that the radiation is not obstructed by other portions of its own surface, and the air has a free circulation around and through it; moreover, its surfaces can radiate heat more freely than a two or three-loop. For the same reasons the two-loop is better than a three-loop, and so on. The more open and exposed a radiator is, the more readily will it give off heat to the air and to the cooler objects in the room (see Fig. 9).

The height of a radiator is also a factor that has an influence on its efficiency ; a low radiator will give off more heat to the air per foot of surface than a high one, for the reason that, the nearer the floor the surface is, the more heat will it give off to the air by contact. The property of radiation, however, is not affected by its height.

My experience leads me to think that the relative efficiency of the different types per foot of surface diminishes about five per cent. for each loop added. If we take that of the single loop as 100, that of the two-loop is 95, that of the three-loop 90, and so on. The relative efficiency of height is not so apparent, and I have not found that less radiating surface can be used with low patterns, for the reason that the low patterns of radiators are almost always bunched together, losing in this way what is theoretically gained by giving up more heat to the air. Low radiators are more expensive than high ones, but they are so necessary under windows, or in other positions where a high one cannot be used, that the extra cost is more than offset by the convenience.

It is well to add here that a hot-water radiator differs from a steam radiator in that it has connections at both top and bottom, while the steam radiator is connected at the bottom only ; this connection being the passage between the sections that go to make up the radiator.

Indirect radiators are also made in various forms and sizes. In the early days of hot-water heating, indirect radiators were made of box coils of iron pipe ; though very efficient, they have been replaced by cast-iron sections, which are much cheaper and do as good work.

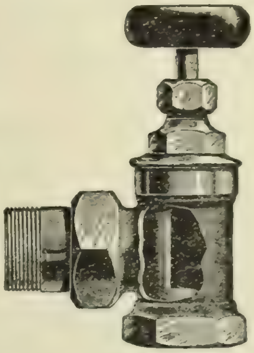


FIG. 10. HOT-WATER VALVE.

The cast-iron fin or pin type is generally used, but a few are made of a type called "prime surface," and are very effective. Almost any of the indirect radiators on the market give good results if properly put up and sufficient surface is put in for the work required.

The valves used in hot-water heating differ materially from those generally used in steam work, though, when hot-water heating first became general, the same valves were used as were used for steam.

For controlling the main distributing-pipes, gate valves are always used, because they offer less friction than any other kind. On the radiators what is known as a quick-opening valve is used ; it works like that of an ordinary plug cock, though not made to shut tight (see Fig. 10). The plug is usually made of sheet brass, and turns in a brass shield, one half-turn opening or closing the valve entirely. When the valve is shut off, there is still a leakage through it, designed to allow enough circulation to prevent freezing in a radiator, should one be shut off in an exposed room. While this leakage is sufficient to keep the water from freezing, the radiator is cold to the touch, if the hand is placed upon it.

The air valves used on a radiator are of a very simple kind, working either with a wood wheel or a loose key. Various attempts have been made to devise an air valve for hot water that will work automatically, but they have not been successful, and as the need for such a valve is not pressing, it is not likely that it will come into general use.

In ordinary residence work valves on the main pipes are not necessary, nor, in fact, are they necessary in any plant, except for convenience in making repairs, for which purpose a large apparatus may be divided into sections with valves to control each one, so that, if any section requires repairing, it may be cut off and drained out. In the same way each set of rising pipes may be valved and cut off without stopping the rest of the apparatus.

The cost of installing a hot-water heating plant in residences, where direct radiation is used, runs from two to three cents per cubic foot of space heated ; when indirect radiation is used, it runs from three to five cents per cubic foot, according to the extent to which the indirect system is employed.

This cost is slightly in excess of that of a steam-heating plant, owing to the fact that all radiators and circulating pipes must be of larger capacity. This extra cost, however, should not exceed 15 per cent. of that of a steam-heating plant. The cost of a hot-water plant, as compared with a warm-air furnace, is about 75 per cent. greater ; but this is compensated for by more economy in operation. The cost of operating a hot-water plant is about 15 per cent. less than that of a steam plant, and about 30 per cent. less than that of a hot-air plant, assuming the conditions in each case to be equal.

PECULIAR FEATURES OF IRRIGATION ENGINEERING IN COLORADO.

By H. A. Crafts.

AGRICULTURE by the aid of irrigation in the United States has so far exceeded in its achievements the expectations of the most sanguine, and still holds so glowing possibilities for the future, that year by year the value of irrigable lands and of the water by which they may be irrigated is largely enhanced, and the quest of water available for irrigation grows more and more keen. Astute engineering minds are constantly employed in devising schemes for increasing the supply of water, and for husbanding it when secured.

In Colorado, for instance, it is safe to say that to-day every available cubic foot of water flowing towards the Atlantic has been appropriated for irrigation or manufacturing purposes. Whether the facilities for utilizing it all are sufficient is another question, but this problem promises to be solved in a few years by a multiplication of storage reservoirs, which are being constructed in great numbers upon the plains by the companies owning the various systems of irrigating ditches now in operation. And it may here be noted that the plains

NEAR THE HEAD OF GRAND RIVER, COLORADO. TAKEN IN LATE SUMMER.

reservoir has proven far better adapted to the irrigation system than the mountain reservoir, for more than one reason. The mountain reservoir usually is narrow and deep, and requires a large dam which may be carried out during a flood, causing enormous damage and possible loss of life by the release of an immense body of water; whereas the plains reservoir may be large in area and formed by some natural depression in the land, supplemented by earth-diking. In most cases the danger of bursting dams is reduced to a minimum, and, as the reservoir is located near or directly in the midst of the lands to be irrigated, the water may be conveyed from the reservoirs to the farm lands with but little trouble.

But many of these companies find that their facilities for carrying water and for storing the same, and the acres under their ditches that thirst for irrigation, increase far more rapidly than the means for increasing the visible water-supply. The temptation to cover more land is constantly before them. Their ditches may be extended almost without limit, and made to traverse lands that need but the fructifying influence of moisture to make them productive almost beyond belief. So the search for more water goes steadily and eagerly on, and the methods employed have in some instances, apparently at least, reversed the order of nature. To be more explicit, they have scaled the crest of the continent, and propose to turn the waters of the Pacific slope into the watershed of the Atlantic. The point is to seek the head waters of those streams whose available supply has not already been fully appropriated for irrigation purposes, and turn certain portions of that supply backward and across the divide, into a

CONSTRUCTION CAMP, BIG LARAMIE CANAL, COLORADO.

CUTTING THE RIGHT OF WAY THROUGH GREEN TIMBER.

different watershed altogether, and add them to that already utilized in the system of irrigation.

To the uninitiated this might seem to be an impossible feat, yet in substance it has been accomplished, and the scheme is in successful operation. In northern Colorado the waters of the Big Laramie, which flow northward into Wyoming and empty into the North Platte river, have been intercepted high up in the Rocky mountain range, and carried, by means of a transalpine ditch, southward across the Medicine Bow mountains and poured into Chambers lake at the head waters of the Cache la Poudre river, whose waters flow southeastward, emptying into the South Platte river in eastern Colorado. This feat was accomplished by the Water-Supply and Storage Company, owners of the Larimer county ditch, one of the largest irrigating systems in Colorado.

It was an interesting piece of engineering, successfully accomplished, although at a loss of nearly $10,000 by the contractors, among the oldest and most experienced firms in the west. Fifty miles they climbed into the rugged mountain range, to an elevation of 9,500 feet above sea-level, or 5,000 feet higher than the plains at the foot of the range, and dug a ditch five miles in length, along the steep mountain sides, now through heavy timber and now along a crumbling hillside, or perhaps through solid rock.

In the first place, all the men, teams, tools, machinery, and provisions employed on the work had to be transported over fifty miles of rough mountain roads, parts of which were constructed for no other purpose than to reach the scene of this exploit. And, when the contractors finally reached their base of operations, there were the surveyor's stakes indicating the location of the proposed ditch far up a steep mountain side, some fifteen hundred feet above camp. Up this mountain side all the tools, machinery, and camping outfits had to be packed on mules and men, involving a long and tedious task. Then there was the difficulty of establishing grading camps and commencing the work of construction on the steep acclivity. It was like working on the slope of a roof. Yet the task was accomplished, and the men and teams went to work.

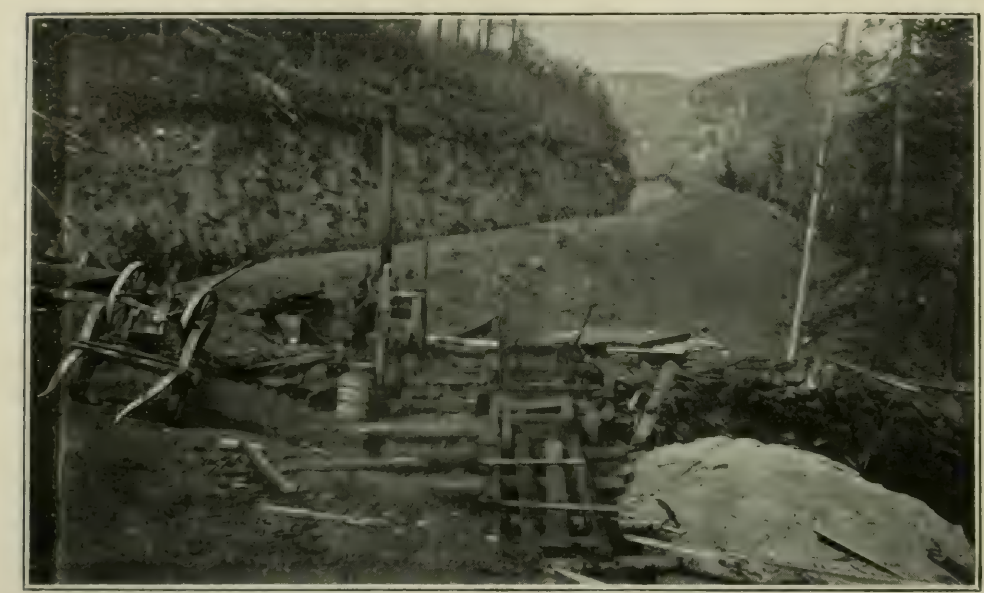
CUTTING IN THE DEAD TIMBER, BIG LARAMIE CANAL.

In the first place, the right of way was cleared of timber and vegetable matter. The trees, not being very firmly rooted in the earth, were toppled over and uprooted by means of guys, and the pine cones, spills, etc., stripped off down to the solid earth. Then followed the mule teams with plows and scrapers, unless the work was in solid rock, when the men commenced the work of drilling and blasting. And, though the adhesive powers of the patient mules were considerable, it was no unusual spectacle to see a mule team rolling down the steep hillside to the gulches below, not, however, with fatal results, the only damage sustained being in the shape of cuts and bruises.

So the contractors labored on from August to December, and then, when the snows and frosts put an end to their work, they found they had accomplished but little more than half of their contract, and were out of pocket $17,000. They returned to the work, however, during the following season, and, by a clever stroke of subcontracting, pulled out in the neighborhood of $8,000 profit, cutting down their net loss on the entire job to $9,000 or $10,000.

But to the ditch company this feeder has proven of inestimable value. It has made their ditch one of the most reliable in the State. No complaints are heard of a loss of crops on account of a lack of water. The company is not only enabled to run its ditch to its fullest capacity during the irrigating season, but to fill its immense system of storage reservoirs, and also furnish water for the irrigation of late crops. The ditch is maintained and operated at a cost ranging from $1,500 to $2,000 per annum. During the open season it is constantly beset by dangers. Rock-slides, land-slides, snow-slides, and cloud-bursts sum up the catastrophes that are liable to occur and carry down yards and yards of the ditch bank, rendering the ditch useless for days together, possibly in the very midst of the irrigating season. Or springs sometimes crop out beneath the lower bank, causing erosions and a final slide of the entire bank. Or the burrow of some animal beneath the bed of the ditch may open a way for the water to start a break, which is equally disastrous. To guard against these untoward happenings, the ditch is patrolled for nine months in the year. About the first of March a crew of twenty men is put to work clearing away snow and all trees or other *débris* that may have fallen in. The trees that stood on the upper bank, by constantly swaying in the wind, loosened the earth in many places, so that it fell

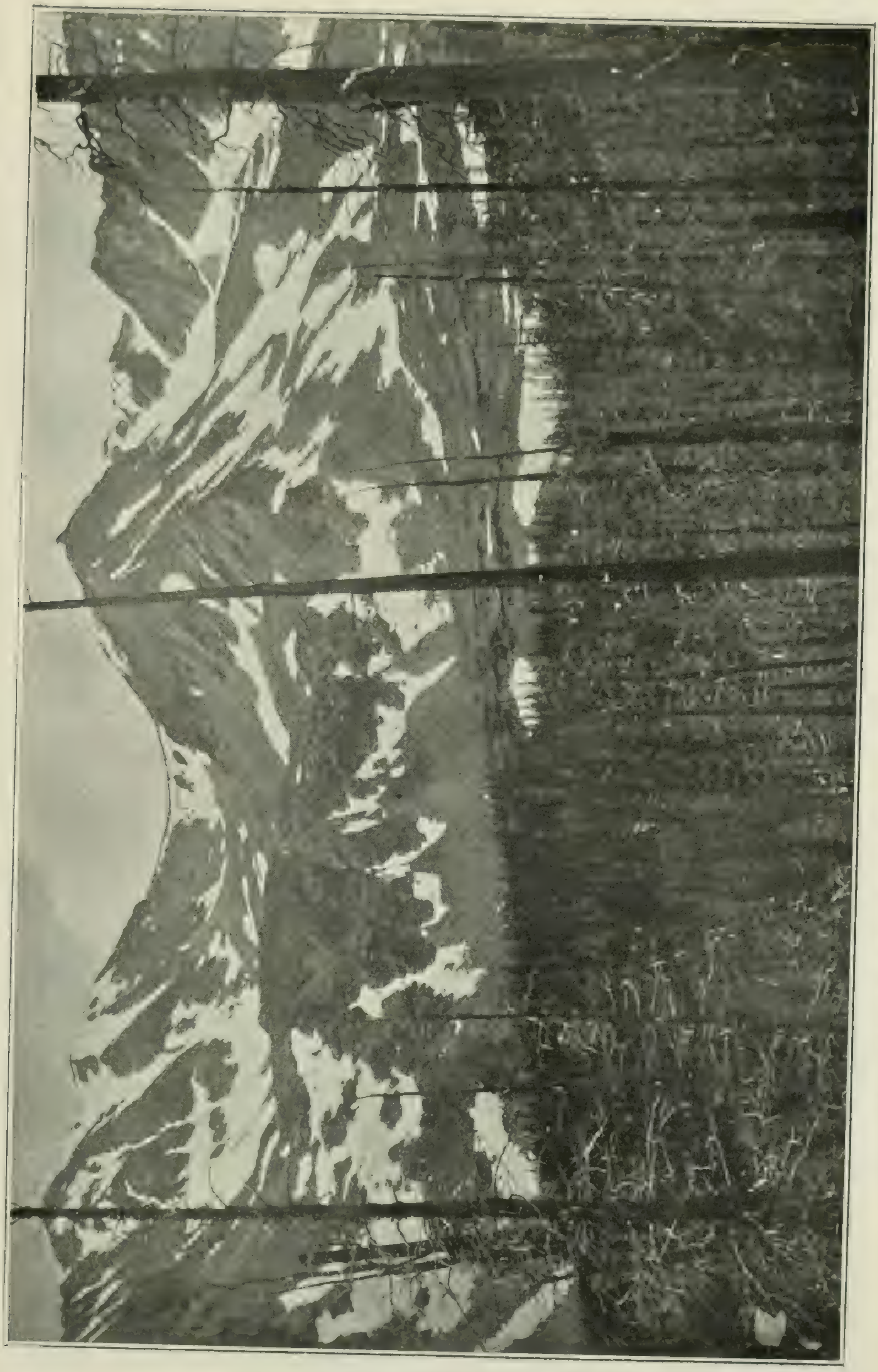
ENTRANCE TO TUNNEL ON THE BIG LARAMIE CANAL.



A SECTION OF EARTHWORK ON THE BIG LARAMIE CANAL.

in masses into the ditch. To prevent this, the timber has all been felled along the upper bank for a distance of thirty feet back. Masses of dirt and rock also fell into the ditch from the action of the frost ; so those portions likely to be affected by frosts have been excavated, and the earth has been used in strengthening the lower bank. Log-curbing is also used to a large extent for the same purpose. To provide against the danger from the sudden influx of water from a

RATING WEIR NEAR THE HEAD OF GRAND RIVER, COLORADO.



THE SNOWY RANGE IN MIDSUMMER, SHOWING THE SOURCE OF THE LATE SUMMER WATER SUPPLY.

CLEARING THE RIGHT OF WAY, GRAND RIVER CANAL.

cloud-burst, a system of automatic spill-ways has been inaugurated at various points along the ditch. These are arranged so that, when the water rises above a certain point, a gate is lifted, and the surplus water allowed to pass off over a weir, thus relieving the ditch from any extra strain. By the constant cleaning and cutting away of the upper bank, the ditch becomes enlarged, and its carrying capacity increased, so that there is some compensation for the work done, outside of the mere strengthening of the ditch. By June 1 all the clean-

GRAND RIVER SUPPLY CANAL, PARTIALLY CONSTRUCTED.

ing and repairing have been finished, and the crew is cut down to four men, who do principally patrol duty until the end of the season,—December 1. Then the snows begin to fall, and ice to form in the streams. Yet the water in a portion of the ditch is permitted to flow beneath the ice all winter, as it tends to keep the ditch clear of snow and ice.

It may seem paradoxical to speak of conducting water from one water-shed to another. The divide seems an insurmountable barrier. In the first place, it must be understood that the head waters of these mountain streams lie high up in the gulches, and are constantly fed by the many springs that gush from the mountain sides and the melting snows that lie in the gorges. In many cases these sources of water-supply lie much higher than the adjacent mountain passes crossing the divide, and the canals are led around the shoulder of the intervening spur and into and through these passes to the opposite watershed.

In the construction of the Big Laramie canal the west branch of the stream was dammed at an altitude of 9,500 feet, at a point on the north side of Clark's Peak, where the stream at high water discharges five hundred cubic feet of water per second. Here the head-gate was located, and the canal carried eastward for a distance, and then curved gradually around the east flank of the Peak, and finally turned in a south-westerly direction and emptied into Chambers lake at the head waters of the Cache la Poudre.

Besides the water taken from the Big Laramie, the canal intercepts and is fed by numerous small streams that flow down the mountain side. In order to carry this augmented water-supply, the canal is gradually increased in size as the outlet into Chambers lake is approached. At present the carrying-capacity of the ditch at its head is about 250 cubic feet of water per second, while at its lower end its capacity is 400 feet per second. It is the intention of the company to gradually enlarge the canal until it can carry all of the water flowing in the west branch of the Big Laramie and all the intervening water-supply as well.

But in this particular case the identical water thus secured cannot be directly diverted to the main ditch of the company. The head gate of the main ditch is fifty miles east of Chambers lake on its outlet stream. So the water discharged by the Big Laramie canal is measured at the point of discharge by the water commissioner, and the ditch company is permitted to take from the river at its main head gate an equal amount of water, less a slight percentage allowed for evaporation upon the fifty-mile journey from Chambers lake to the plains. The use of the natural bed of the stream for the conduct of water thus contributed to its volume is authorized by legislative enactment, and, although it was strenuously opposed at the outset, it has so far stood the test of the courts.

A similar piece of work is about to be undertaken by the National Land and Irrigation Company, owners of the North Poudre canal and a vast amount of land in northern Colorado. The North Poudre canal is fifty-two miles in length, and has as an adjunct a system of storage reservoirs whose aggregate capacity is 812,000,000 cubic feet of water ; yet its water-supply is far from adequate to the wants of the company. It has thousands of acres of excellent land that only needs moisture to make it highly productive. So the chief engineer, Mr. A. G. Allan, is busy upon schemes to secure the needed supply. His pet scheme is the construction of a transalpine canal that shall bring water from the head waters of the Grand river (a stream which has its rise in the main range of the Rocky mountains in northern Colorado and flows southwestward, emptying into the Colorado river, which in turn empties into the Pacific ocean) over the continental divide, and deliver it into the head waters of the Cache la Poudre river, which rises on the eastern side of the range and flows down the Atlantic slope.

During three months of the summer and fall of 1897 Mr. Allan, at the head of a crew of men, was engaged upon the preliminary work of this proposed canal. High up, near the summit of the great range, in regions of perpetual snow, he ran surveys, constructed rating weirs, and even commenced the excavation of the canal itself. Mr. Allan, during his stay upon the head of the Grand, took a number of photographs, which have supplied the illustrations accompanying this article. A careful investigation established the feasibility of the scheme, and another year will doubtless see it consummated, when water that has hitherto found its way westward to the Pacific will be turned back upon its course and led eastward across the range, and thence upon the plains of eastern Colorado.

The head waters of the Grand lie in a fan-like shape, enclosed by a continuous range of mountains, many peaks rising 13,000 feet above sea level. The mountain range is in the shape of a horseshoe, and faces south. The lowest pass—Mountain Meadow park—is situated at the northeast corner of the horse-shoe, and is low enough to allow a ditch draining the larger portion of the Grand river basin to discharge its waters into the opposite drainage area, or the basin of the Cache la Poudre river.

All of the creeks which feed the Grand river in this neighborhood tend in an easterly and southeasterly course, and are, with two exceptions, on the west side of the Grand. The proposed ditch is on that side of the river, and will cut off practically all of the water before it reaches the main stream, and discharge it over the pass into the Cache la Poudre. The creeks are situated in a gulch many hundred feet below the surrounding mountains, and, as they run east or west, the north winds blow the snow, above timber-line, into these gulches, until the drifts are fifty feet deep. This is the main source of water supply for the head waters of the Grand river.

This drainage basin has an area of about seventeen square miles, is densely covered with heavy spruce and pine timber, and has, every winter, a heavy fall of snow. In the winter of 1897, in the woods, where it did not drift, the snow was from five feet six inches to eleven feet deep on a level. This fall was above the average. There is no doubt of the enormous fall of snow in this region. The creeks commence to discharge about April 15, increasing in quantity until the first week in July, after which there is a continual decrease until they freeze.

In the Grand, below the junction of Saw Mill and Camp creeks, Mr. Allan constructed a rating weir; also one in South Lead Mountain creek. He kept a daily record, which shows an average monthly discharge of water which would give to a canal, discharging a maximum of 80 cubic feet per second, sufficient water for more than 4,000 acres of land during the irrigating season.

In regions of this description Mr. Allan favors the building of narrow, deep ditches with steep grades. One of his reasons is that the first cost of construction is much less than that of wide shallow ditches. Another reason is that the cost of repairs rendered necessary by snows and storms is less. In California ditches carrying 80 cubic feet per second have been built, and are in successful operation with grades from sixteen to twenty feet to the mile.

The secret of the large and late run of water in the Grand river is the very low temperature prevailing at that altitude. There were only three nights in July, 1897, and two in August, that the thermometer did not drop to 32 degrees. This low temperature has a direct influence upon the creeks, the highest discharge being about 6 o'clock P. M., and the lowest about 7 o'clock A. M. In case of the weather remaining cool for several days together, the snow melts so much more slowly that the decrease of water-supply is about forty per cent., and thus the flow of water is greatly prolonged.

In the way of construction, the work performed consisted of the clearing of the right of way of all timber and the felling of all trees liable to fall across the ditch from storms or forest fires. The top soil was also removed for a part of the distance. This soil consists of decayed vegetable matter, and will be removed not only from the bed of the ditch, but from the ground that will underlie the banks in order that the latter may have a solid foundation. The material excavated from the bed of the ditch will all be used to raise the lower bank, which gradually solidifies into a firm mass. In general, the use of flumes is to be avoided, but about 3,000 feet will have to be used on the Grand River canal, 1,700 feet being through hard, porous, and shattered material. For the construction of flumes native spruce can be obtained at $8 per thousand feet. The flumes will be made as nearly water-tight as possible, as leakage would loosen, and perhaps destroy, the foundation. The cost of similar canals in California was from $7,349.20 to $8,485.40 per mile, but the cost of the Grand River canal will be less, on account of the lower rate of wages. There will be a disadvantage of location, distance from railroads, and the difficulty of transportation over mountain roads, many of which will have to be rebuilt, but these are considered minor matters compared with the obstacles which were encountered in the construction of the California canals.

The canal, when completed, will be five miles in length, ten feet wide at the bottom, and from twelve to fifteen feet wide at the top, and will carry water to a depth of three and one-half feet. The canal can be operated after the first year with a force of three men and a superintendent, at a cost of $245 per month, or $1,720 for the season. The annual cost of operating and maintaining large ditches, including in the calculation of annual expenditure all repairs and taxes, is estimated at $400 per mile.

When completed and in operation, the canal will deliver Grand river water into the Little South fork of the Cache la Poudre, and thence the water will flow into the main stream and down to the plains, some fifty miles distant, where it will be delivered pro rata to the various ditches on the main Poudre, in return for which the National Land and Irrigation Company will be allowed to take an equal amount from the north fork of the Poudre for supplying its ditch and reservoirs.

A more reliable and satisfactory source of water-supply could hardly be imagined than that afforded by these lofty regions. Besides the heavy rainfall to which they are subject during the summer months, there are inexhaustible deposits of snow and ice in the deep gorges of the upper peaks. These are melted by the summer sun, and keep all the creeks and rivulets running full, the flow of water depending largely upon the amount of sunshine expended upon the snow-banks. These snow-banks act as a reserve, and furnish water long after the snow has melted from the mountain sides and the other sources of water are well-nigh exhausted. This late water becomes very valuable in the irrigation of late crops which might suffer from drouth if dependent solely on ordinary sources of supply.

The extent to which this method of obtaining an additional water-supply could be developed depends upon the amount of unappropriated water that may be found in neighboring watersheds, and feasible routes for the construction of supply-canals across the intervening divides.

There are undoubtedly large quantities of unappropriated water still flowing down the Pacific slope of the Rocky mountains, but, as agriculture is rapidly coming to the front in that region, it is only a question of time when all of the available water-supply will be appropriated. Yet the ditch companies of the eastern slope are not slow in taking steps to secure all the water possible from that source before the supply shall be exhausted.

SUPREMACY IN THE IRON MARKETS OF THE WORLD.

By J. Stephen Jeans.

IV.—CONDITIONS AFFECTING THE ECONOMICAL MANUFACTURE OF FINISHED PRODUCTS.

IN previous articles we have considered the competitive circumstances of different countries in reference to raw and semi-crude materials. We have now to deal with the conditions under which the same countries produce finished products in the forms of rails, plates, bars, angles, wire rods, and similar commercial commodities. This, it is obvious, is less a question of natural advantages, and more a question of the cost and efficiency of labour, and of the command of economical appliances and processes, than any of the aspects of metallurgical status already dealt with in the present series.

In a letter which he wrote to Horace Mann, more than a hundred and twenty years ago, Horace Walpole declared that he believed that "England will be conquered some day in New England or Bengal," and on another occasion he wrote to the countess of Ossory that "there are many able Englishmen left, but they happen to be on the other side of the Atlantic"—referring to the United States. The first statement appears to have been almost prophetic ; the second had some truth, if much exaggeration. If we take New England as typical not only of the eastern States, but of the middle and southern States as well, Walpole's prediction is within measurable distance of fulfilment ; at any rate, British supremacy is being challenged. I do not thereby imply that the British are to be vanquished, because they are scarcely made that way. By and by, no doubt, it will resolve itself into a tug of war, to which Wellington's remark at Waterloo will probably apply : "Hard pounding, this, gentlemen ; let's see who will pound the longest."

Some years ago I submitted to the royal commission on labour a memorandum as to the conditions of British and foreign industry, published in their very voluminous reports, in which it was shown that, of the total production of steel in the five chief iron- and steel-producing countries, in 1870 and 1890, the part contributed by the United Kingdom fell from 45 per cent. in 1870 to 23 per cent. in 1890 ; that the per cent. of contribution of the United States rose from only 9 per cent. in 1870 to 50 per cent. in 1890 ; while within the same period the United States increased their proportion of the total make of finished iron from 22 to 37 per cent., against a decline from 43 to 26 per cent. on the part of the United Kingdom. These figures sufficiently indicate the character of the movement that has been in progress during the last quarter of a century, and more recent figures need not be added.

When, however, we come to deal with the foreign trade of the same countries, a very different state of affairs is revealed. The following figures show the exports of iron and steel from each of the countries named relatively to its production of pig iron, wrought iron, and steel for 1895–96.

	Output 1=1000 tons.	Exports 1=1000 tons.	Percentage of output exported. Per cent.
Great Britain	11,824	2,883	24.39
Germany	9,593	1,523	15.87
Belgium	1,643	489	29.74
France	3,466	209	6.02
United States	15,886	91	0.57

These figures demonstrate the greatly-preponderating importance of Great Britain as an iron- and steel-exporting nation, despite the fact that the little kingdom of Belgium exports a larger relative proportion of annual output. Germany, moreover, has been creeping up with steady pace during the last few years, although, somewhat anomalously, she shows for the current year a large falling off, compared with 1896, while Great Britain shows an advance of nearly two hundred thousand tons. The most remarkable part of all, however, is the relatively limited export trade of the United States, which exported a little more than half of one per cent. of their enormous output of almost sixteen million tons. On the face of it it seems almost ridiculous to speak of a country so far behind in foreign trade at so recent a date as likely to do anything in the near future of which competitive nations need entertain the least alarm.

The United States, as every manufacturer and economist knows, have not entered the arena of foreign competition hitherto to any material extent, because of the enormous demands at home, and the aid lent by those demands, and by the maintenance of a protective system in keeping up prices. My friend, Mr. Edward Atkinson, of Boston, with whom I have had valued opportunities of discussing this subject, has shown * that the *per capita* consumption of iron in the United States has increased from 270 pounds in 1880 to 320 pounds in 1889, and that the apparent disadvantage of the United States in the cost of iron and steel from 1880 to 1890 has been about $700,-

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* "The Industrial Progress of the Nation," p. 277.

000,000, in view of the results of the tariff.[*] While these two controlling influences were at work, prices were kept at a high level, and there was no incentive to attempt business in foreign markets. American manufacturers, moreover, had not yet set their house in order in the matters of low costs of mining, cheap transport, efficient labour, and modern plant—the four factors that have brought about the new revolutions, and threaten to repeat the history of the last century, when the American colonies exported considerable quantities of iron (charcoal) to England.

To enable the reader to understand the causes and the character of this new order of things, it is necessary to say something of the conditions which have been superseded.

The controlling factor is, of course, the cost of the pig iron at the steel works. This cost was necessarily high at a time—no more than twelve years ago—when the cost of assembling at the furnace the materials required for a ton of pig was 35s. at Chicago, 32s. to 34s. at Cleveland, and 35s. to 40s. at Pittsburg.[†] At that time transport alone, in some cases, appears to have counted for almost as much as the whole cost of production, transport included, at the present day. Among the many differences that distinguish American from British conditions, this is not the least important. With the iron industry of the mother country, circumstances have not changed so largely or so rapidly. Indeed, the transportation conditions of to-day are much the same as those of fifteen or twenty years ago.

The American iron industry differs from that of any European country in respect of two things: first, in the conditions of supply and demand; second, in the methods adopted by leading manufacturers in production and distribution. Mr. Andrew Carnegie, in 1896, declared that "the manufacture of iron and steel is subject to greater fluctuations than almost any other branch of business," and that "this arises from two causes: first, the demand caused by increased activity and development, as scarcely anything nowadays can be built without this material; and, secondly, because the amount of product cannot be rapidly increased. New mines have to be opened, new railways built, new blast furnaces and new mills, before much additional finished product can be obtained. This takes time, capital, knowledge. High profits of existing works tempt their proprietors to enlarge capacity, and inexperienced capitalists are tempted to engage in the manufacture. By and by, capacity far exceeds consumption, and then follow some years of depression, to be followed in due course by a year or two of great profits.'' *

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[*] It is only fair to Mr. Atkinson to point out that in 1889 he predicted the export of pig iron from Alabama to England as a result of tariff revision.

[†] These are the figures that were given to the Royal Commission on Trade Depression, Dec. 16, '85. See Report, p. 361.

But American methods have also at least as much to answer for as causes that appear to be a good deal more beyond control. Those methods are sufficiently well known to men engaged in the trade on both sides of the Atlantic. I need not again go over the well-trodden ground of the early history of the bessemer steel industry in the United States, or speak of the zeal, enterprise, *esprit de corps*, and mechanical genius of that highly capable band of then young men, who, under the guidance of my late and greatly-esteemed friend, Mr. A. L. Holley, took the technique of bessemer practice out of the European ruts, and placed it on a much higher level of attainment. Holley's example and aspirations have been a spur to all who have followed him as metallurgical engineers and works managers, and for at least a quarter of a century the constant aim of the Americans has been to ''beat the record,'' or, in other words, to produce more cheaply than ever before. This spirit and effort have had the most ample encouragement from capitalists like my friends, Mr. Carnegie and Mr. A. S. Hewitt, who have always been willing to afford chances to those who believed in themselves, and who have recognized the importance of keeping up their manufacturing plants to the highest level of modern practice. This, of course, has been an exceedingly costly business. I am bound to say that the expediency of readily adapting equipment to modern invention has not been realised in any European country to the extent that it has been in the United States. It is still a debatable point whether the vast expenditure incurred in modern American iron- and steel-manufacturing plants is justified by results, and whether the British system of keeping down capital expenditure as far as possible is not, on the whole, more satisfactory. I have talked over this matter with many leading men in both countries, and have reached the conclusion that the differences in the circumstances of the two countries create essential differences, not only in the conditions to be met, but in the most expedient and economical methods of meeting them. In other words, it would hardly pay a manufacturer in England to make on his plant so lavish an expenditure as is common in the United States, because he has no guarantee that, when he has done so, he will secure orders to keep it employed. His prospects of home orders are certainly not sufficient to do so, and he cannot, like his American and German rivals, accept orders at more or less unremunerative prices in order to keep his plant going, for, unlike them, he has no protection behind him in his home market, nor has he—at any rate for the majority of his products—the more temporary advantage of a syndicated price.[*] All this means that, in a general way, the efficiency of a typical American plant is greater than that of a typical British plant. In other words, all other things being equal, the American plant will produce a larger quantity of material in a given time at a less cost, because it is specially designed and constructed with a view to that result. It is true that the American plant has involved a larger capital outlay, but the charge upon this difference does not amount to much, in view of the enormous outputs now usual in American practice. It is manifest, in this connection, that it would hardly pay European manufacturers to build and maintain equally costly plants, unless they attempted much more than they do at present in the way of securing orders from all parts of the world, without too closely counting the cost. *Cæteris paribus,* therefore, the American manufacturer has more efficient means of production than any European nation, and is likely to continue to have, so long at least as his own country affords guarantees of a demand that will keep his works fully employed, if he can shape his plans so as to secure the lion's share of the contracts.

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* "On the American Iron Trade," *Iron Age*, January 2, 1896.

It can hardly be without interest, and perhaps it may be of some use, if I set down an authoritative statement of the cost of the production of American steel rails twenty years ago at a leading Western mill. The metal used per ton of rails cost $41.83, which is four times as much as the cost of a ton of bessemer pig within the last few months; fuel per ton of rails, including bessemer department and rail mill, cost $5.65, whereas I know of at least two works—among the most important in the United States—where the cost of fuel per ton of rails does not now exceed 50 cents, or less than one-eleventh of the price then paid, while labour cost $11.15—$3.50 for commission and the rest at the mills—against a cost of less than $3.00 at the present time. The total cost of a ton of steel rails at that time was more than $69.00, whereas the total cost of a ton of steel rails to-day, under the most favourable American conditions, does not exceed $16.50, or less than one-fourth.

In Europe there have been no similarly extraordinary changes in costs and values, because no European country started from an equally high level in respect to both. The cost of bessemer pig iron, fuel, and labour has certainly varied in Great Britain, but within comparatively narrow limits, if we except the years 1872–74 and 1880–81; and as with Great Britain, so with other European countries. Probably the greatest change of all has taken place in the cost of labour, which is not one-third of what it was a quarter of a century ago. Of course, also, there has been great economy in other directions, and one British firm is now, I believe, ahead of all others in respect of its bessemer plant, which has 20-ton converters against 5-ton converters employed at the same works a quarter of a century ago.

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[*] In some cases British manufacturers *do* have an understanding as to prices, but rarely on binding penalty terms.

My own experience and information lead me to suppose that at the present time there is very little difference in the cost of producing steel rails in the best European practice, but American costs must continue to be somewhat less, if our American friends continue this ability to produce bessemer pig at 40s. per ton, or less. It is highly improbable that the same description of pig will ever be produced in Great Britain, Germany, or Belgum, at this low price, because these countries have to depend so largely on imported ores, and have not so cheap fuel as the United States. The item of labour at works is now a relatively small one, in all countries alike. Owing to the long distances over which American manufactured products have to be carried, the uncertainty that always waits upon freights, and the limited amount of shipping directly under their own control, the Americans will not, however, have so assured a position in the world's markets as they would have, had they the British conditions to deal with, apart from those attaching to raw materials; and therefore it seems to me that the race will always be more or less uncertain in its issue, and it is likely to be all the more so because of the rapid and large fluctuations in the home American demand.

Another obvious advantage possessed by American manufacturers is the greater absence in the United States of prejudice or conservatism, and the consequently more ready application of new ideas and methods. This tendency and its results have been well set forth in a recent issue of an American trade journal, in the following terms:

> The old order of things has been considerably upset by the introduction of labor-saving machinery in the great steel works of the country. This movement began several years since with the improvement of the steel rail mills, was brought to a highly-advanced stage of development in the Homestead works, leading to the memorable strike of July, 1892, and, since then, has been making its way in all departments of the iron and steel trades. Special progress has been effected, however, in the steel works. Here engineers have been working on independent lines in the several establishments, attacking time-honored methods with audacious ingenuity, in order to secure some advantage over competitors in cheapening production. Wherever work accumulated, or even a small force of men has been required, the engineer recognized a problem to be solved by the application of an improved mechanical appliance. Improvements of this kind are in many cases peculiar to the plant, being compelled by the manner in which the works were originally laid out, when enormous increase in production was not contemplated. Correctly-devised apparatus has enabled some rather antiquated establishments to put themselves in line with modern works in the

economical handling of material in intermediate processes of manufacture. If it had not been for these improvements, they would have had to fall out of the race, and await the coming of better times and higher prices.

And so it is in most American industries. Methods and appliances are less stereotyped than in Europe, so that hardly any two works carry on the same processes on exactly the same mechanical lines. We know less of these differences in Europe.

But American commercial practice differs from that of European countries perhaps as much as American technical methods differs from those of Europe. So much is this the case that I happen to have excellent means of knowing that the largest steel-manufacturing firm in the United States last year made a very handsome net profit, while the next to the largest made no net profit at all. The American manufacturer knows that there are sufficient orders in his own home market to keep even his largest plants fully employed, if he can only make sure of them, and, as he knows the vast importance of working full time, every effort is made to that end, almost regardless of price in times of depression. British contractors, however, generally look first to a profit, and, if there is little or no margin, the work is probably declined, so that the plants are often kept more or less idle for considerable periods.

In 1876 Mr. (now Sir) Lowthian Bell, in a report on the Centennial Exhibition, at which he was a metallurgical juror, declared that, so far as skill of manipulation and general efficiency of work are concerned, he could "detect no difference between the old and the new country in the rolling mills. I had the opportunity of comparing two rail mills,—one turning out 70 tons per turn at Middlesboro (England), and the other 67½ tons in Pennsylvania. The number of men employed at the two was almost exactly the same, but the cost for labour per ton was fully 25 per cent. higher in America than in this country (England)." He adds that, "in one case which came under my notice in rolling bar iron, I found the price paid in America to be nearly double that paid in this country (England)." It was not, therefore, until a later date that the Americans began to wake up. Indeed, Sir Lowthian Bell mentions that in 1876 there was not in the United States a single case in which the American bessemer works used direct metal, whereby 5s. per ton of steel could be saved.

Upon two points of importance the conditions in the United States must have greatly changed during the last twenty years, or Sir Lowthian Bell must have been far out in his calculations when he wrote his report as a juror at the Centennial. In that report he states that "the native-born Americans evince more than a disinclination to apply themselves to the severe labour of the mine and the ironworks, and, in consequence, fresh hands are almost exclusively recruited from immigrants."* Elsewhere he says that, "on the whole, the men engaged in mining and smelting were not much better paid than were similar classes in Great Britain."†

It seems to me that, if there has been any one thing more clearly established than another in the history of American industry, it has been the marked disposition of Americans to apply themselves to "severe labour"—meaning thereby strenuous exertions maintained over an exceptionally long period. It is true that they have largely succeeded in getting rid of the most exhausting part of the old manual toil—in mining, by the use of mechanical coal-getters, steam shovels, etc., and in metallurgy by a whole series of mechanical improvements whereby the work of the blast-furnaceman, the steel-smelter, and the roller has become much more automatic than formerly; but Americans are generally content to work much longer hours than are worked in England, and, however much they may have inoculated immigrants with their own strenuous ideas and habits, it is manifest that the impulse to work at high pressure for long periods must have come from the native-born Americans originally, since the immigrants have no such records to show at home as are shown in the United States.

As regards the rates of wages paid in the iron works and kindred establishments of the United States, they were certainly much higher in the seventies, and over a large area are much higher still than in Great Britain. This is shown by Sir L. Bell's own figures ‡ in 1876, 1884,§ and 1890.‖ A statement submitted some years ago to the tariff commission by the then vice-president of the Illinois Steel Company, my friend, Mr. W. R. Sterling, showed that the average annual wages paid to the then 9,500 employees of that great corporation was nearly £3 per week, and figures recently compiled by the *Iron and Coal Trades Review* show that the price paid for sheet-rolling in a typical American works was stated to be $4.22 in England and $10.65 in America. But there is no need to labour over this point, for it is hardly nowadays disputed that the range of wages in American mines and works is, and has long been, materially higher than the corresponding figures for Great Britain, or for any other European country.

This, however, is not the real point at issue. We are not concerned so much with the nominal rate of wages as with the wages cost of a given product, which may be, and often is, a very different thing. The truth is that the higher rate of wages which they have been compelled to pay has been the salvation of American manufacturers from an international standpoint. This apparent paradox is easily explained. High labour-costs have compelled the manufacturers of the United States to exert themselves in so perfecting their equipment as to get rid of manual labour whenever that was practicable. The results of this necessity have been astounding in a large number of cases with which I have been made acquainted. I have been shown balance-sheets and cost-sheets for leading American works where the labour-cost was very much under anything I have ever heard of in any European country. The particulars so communicated were submitted under the seal of confidence, and therefore I can say no more about them; but they confirm the remarkable evidence of low labour-costs given by my friend, Mr. Franklin Hilton, in his interesting series of articles recently published in the *Iron and Coal Trades Review*. In one of these Mr. Hilton states that at the well-known Lorain works "600 tons of ingots have been produced in twelve hours, with only sixty men in the bessemer shop, including all labour." Now, if we take the average wages paid to these men at £3 per week,—it is likely to be materially less,– and assume that this rate of output can be maintained six days per week throughout the year, it would mean an average labour cost per ton of ingots of little more than 4½d. If it were maintained for one-half of the year, the labour-cost per ton of ingots would be only about 9d., and I know of no British works that can show anything like this low figure. *Mutatis mutandis*, the same remarks and conditions apply to the rolling mills and auxiliary departments of American steel-works. A ton of steel rails can be produced in Pittsburg to-day more cheaply as regards labour than in any other part of the world.

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* "Report on the Iron Manufacture of the United States of America," p. 37.

† Ibid, p 38.

‡ See Report of 1876, pp. 30, 31, 36, and 37.

§ "Principles of the Manufacture of Iron and Steel," pp. 555, 562.

‖ "The Iron and Steel Institute in America in 1890," pp. 149, 183, and 198.

I purpose now to jump from the highest rate of wages, or nominal labour costs, to the lowest that exist on a considerable scale, because sharp contrasts have a tendency to accentuate notable facts. Belgium, which competes with Great Britain, Germany, and the United States in many neutral markets, does not, like the American steel works, pay an average wage of about £3 per week, or, say, £140 to £150 a year, but one of only £41 per year.* In other words, the average wages paid in a recent year by the Illinois Company to all its employees was considerably more than three times the average paid in Belgium to *all* similar employees. What was the comparative result? The average labour-cost per ton of finished steel in Belgium

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* The most recent official report on the metallurgical industries of Belgium shows that in 1896 the average wages paid to *all* the hands employed in steel works was 3½ fr. per day which, converted at 25 fr. to the £ sterling, for three hundred days gives this figure.

—obtained by dividing the total ascertained finished product into the total wages paid—was 10.8 francs, which, while much lower than the Belgium average of a few years ago, is still considerably higher than the average of the best American practice. The average product per man in Belgium was, of course, much under the American average, whatever the latter might have been, and ridiculously short of the best American practice, as illustrated by the Carnegie works, the Lorain works, and other well-known establishments.

As for Germany, she labours under disadvantages which I have already named in respect of the comparatively higher cost of her production of pig iron. That cost, however, has been considerably reduced of late years, as the following official statement of average annual prices shows:

Years.	Bessemer pig marks or shillings per ton.	Basic pig marks or shillings per ton.
1890	79.83	60.96
1892	57.82	49.33
1893	52.00	45.54
1894	52.00	45.17
1895	52.00	45.63

These figures compare unfavourably with British prices for both descriptions, and rule Germany out of the competition, unless she can show compensating gains, and I do not believe that she can. I found, when going over Belgian and German works, two and a half years ago, that the labour-costs of production did not much differ from the British, so far as I know them, and in Westphalia the wages are much the same as in some leading districts of Great Britain.

I must now put in a short plea for quality of product, which is important, although not so all-controlling as price. In not a few cases, it is believed, British manufacturers produce a higher quality of product than those of any other country. In many other cases, it is believed, the American products are coarse and unreliable; and it is pointed out that, as the great aim of the manufacturers there is to get quantity, they give little attention to quality. There appears to be sufficient ground for both views, which I will not admit to be mere prejudices. It is not alleged that the Americans *cannot* produce a high quality at any cost. The question is: Does their general system admit of it? Now, if this idea continues to be entertained, whether justified or otherwise, it is to be presumed that the British manufacturer, at the same price, will get the preference—at least until the Americans have stood for more care and higher quality.

On a consideration of all the facts and figures, I must, in the main, express my substantial agreement with the views recently expressed on the future industrial position of the United States in a leading American trade journal. The *Iron Age* has stated that "the United States is now entering upon the commercial career long ago seen to be its manifest destiny. Hitherto it has been in a formative or preparatory state. Its citizens have been engaged in the costly and arduous work of developing its natural resources, establishing intercommunication, diversifying industries, and endeavouring to supply their own requirements as far as possible. They have always raised surplus crops, and have helped to feed the world. They are now in a position to turn out more manufactured articles than they need, and are assisting to supply the wants of the rest of the world in that regard. Unless remarkable and calamitous changes take place, the United States will from this time be a large seller of all kinds of commodities, raw and manufactured, and a comparatively small buyer. This combination will surely make it the richest country in the world. No other nation on earth is so well situated to become the future workshop of the world. Nowhere else is food so abundant and cheap, with manufactures so well established and the finest raw materials so plentiful and accessible. In its ability to sustain itself the United States is unique among nations."

While this is "just so," it does not by any means follow that the United States will have it all their own way. It remains to be seen how far some European countries, and notably Great Britain, can in the future approximate American conditions, or, in other words, how long American manufacturers are to enjoy a position "unique among nations."

I have now, I fear, exceeded the limits assigned me for the present article ; but, in a concluding paper, I hope to sum up the whole subject with a view of showing the extent to which different countries have occupied neutral markets, and reach reasonable conclusions as to the prospects of the world's iron trade in the future, regarding costs and conditions of supply, as well as the countries whose supremacy will be established and maintained.

REVIEW OF THE ENGINEERING PRESS

CONTENTS.

ARCHITECTURE AND BUILDING.

Maltese Architecture.................862
Pompeian Restorations 872

CIVIL ENGINEERING.

Inland Navigation.................... 868
River Gagings in France 870
The Müngsten Viaduct 871
Slag as a Material of Construction.......876

ECONOMICS AND INDUSTRY.

The Education of Engineers............859
Foreign Machinery in England ... .861

ELECTRICAL ENGINEERING.

Utilization of the Power of the Arc......869

MARINE ENGINEERING.

The Performance of Screw Propellers....855

MECHANICAL ENGINEERING.

Automatic Stokers.....................853
A Large Power Plant... 858
The Armor-Plate Board... 858
Animated Pictures.... 860
English and American Tools.. 865
A Power Gas Plant.....................866
Theory of Centrifugal Pumps...........867
Strength of Wire Rope............... 873

MINING AND METALLURGY.

Antique Copper Tools 875

MUNICIPAL ENGINEERING.

Incandescent Gas Mantles 863
Healthful Buildings...................864

RAILWAY AFFAIRS.

American Locomotive Building 856
Geared Locomotives....................857
English and American Freight Cars.....861
New Railway Station at Paris..........874

STREET AND ELECTRIC TRAMWAYS.

Electric Tramway in New York....... .854

Automatic Stokers.

FOR several months past the Franklin Institute has been investigating the smoke nuisance, and the various methods for its prevention, not because Philadelphia is now suffering from excessive smoke, but rather because the increasing use of soft coal has caused apprehensions for the future.

The investigation took the form of a public symposium at the meetings of the Institute, many specialists from various parts of the United States contributing, either orally or by correspondence; the reports of these meetings form a valuable contribution to the practice in smoke-prevention in different sections of the United States.

Supplementing this discussion, another has been held upon the subject of mechanical stokers, and the publication of this portion of the symposium is begun in the *Journal of the Franklin Institute* (December, 1897). In the discussion a number of well-known mechanical stokers were illustrated and described, and there was evident appreciation of the advantages of mechanical firing, especially for those locations in which the demand for steam was fairly uniform and sudden fluctuation in load the exception.

A number of valuable points of practical importance in connection with the combustion of coal were also brought out, and some of these will bear repetition and emphasis. The fact that freedom from smoke does not necessarily mean economical combustion was in some cases fully understood. As one of the contributors remarked:

" The fallacy of the general notion that a clear stack signifies economy, and that a smoky stack means wastefulness, is being appreciated more and more. The principal loss from the incomplete combustion of gases is not indicated by the appearance of the chimney mouth, but is due to the escape of invisible gases, and the visible smoke formation is a rather insignificant item of loss. The experiments of Professor Tatlock, of Scheurer-Kestner, and those made at Sibley College all tend to show conclusively that the average heat losses due to the formation of smoke do not exceed three-quarters of one per cent."

Smoke-prevention is rather to be regarded as a measure of public hygiene and cleanliness than as a problem in the economical generation of steam, but in all large cities the former conditions should rule, even at the expense of economy. Neglecting, then, the question of the value of smoke-prevention as a measure of economy, automatic stokers may be considered upon their merits, merely as substitutes for hand-firing; and in very many instances, remarkably good showings have been made. As one of the speakers said: "All stokers are good, but some are better than others." The constant and uniform feeding of the fuel is undoubtedly conducive to thorough combustion, and with the traveling grates used in many forms of apparatus, a clean fire is assured. One source of economy resulting from mechanical firing is the greater length of life of boiler when freed from sudden changes of temperature. To quote the experience of an extensive user: "The heat in the furnaces being maintained so constant and regular, the time lost in overhauling and repairs of the boiler was very much reduced—an entirely unexpected source of saving and safety."

So long as coal continues to be burned directly under the boilers which are to receive the heat, there is little doubt that mechanical stoking offers material advantages over hand-firing. It seems, however, to be but a partial solution of the problem, and some day perhaps we may wonder why the barbarous practice of burning fuel within city limits and discharging the products of combustion directly into the atmosphere was ever permitted.

In the words of a review of this subject in these columns written several years ago: "The use of gas-producers and the methods of using producer gas are surely well enough known to bear wider application than has yet been given, and the present practice of firing each boiler independently is not much less primitive than would be the use of separate gas retorts for the production of illuminating gas for each establishment. The introduction of electrical methods of distribution of power would make it altogether possible to have power-generating plants placed entirely outside the limits of our large cities, and enable vast batteries of boilers to be fired with smokeless gas, generated from the lowest grades of coal in independent producers; while the power developed in engines of highest efficiency and transmitted and subdivided by electricity might almost rival in cheapness that which is to be obtained from Niagara. That such a plan contains some of the elements of experiment cannot be denied, but that the uncertainties, either of cost or construction, are greater than those of the control of the great cataract may well be doubted; and the entire elimination of the smoke problem would be included as what might perhaps be termed a negative by-product."

Since these words were written, the control of Niagara has become a fact, and the question of gas-firing is progressing with some success; but much remains to be done before the clouds of smoke and steam shall cease to obstruct the light, and foul the air, of the cities of America.

Electric Tramways in New York.

One of the most important installations of electric traction yet constructed, and certainly *the* most important underground system, is that of the Metropolitan Street Railway Company, of New York, of which an excellent illustrated account is given in the *Street Railway Journal* (December, 1897).

New York city, from its peculiar topography, is especially adapted for mechanical or electrical traction. The long, narrow shape of Manhattan island, and the concentration of business at one end and residences at the other demand a rapid and efficient transportation service almost of a miniature trunk-line nature.

The unalterable opposition to the overhead trolley has retarded the introduction of electric traction in New York, but the great increase in travel, and the manifest inadequacy of the Broadway cable line and the elevated railroads to meet the demands of the public, have compelled the management of the Metropolitan system to install the underground electric trolley.

The system adopted was of the simplest nature, consisting of a conduit containing two conductor rails suspended from porcelain insulators, and transmitting the current through suitable contact shoes to the motors upon the cars. The road-bed, conduit yokes, and concrete masonry are of the most substantial construction, the weight of rails and yokes being greater than has been employed in any previous road, and the work, which has been in progress for the past three years, is now nearly completed, a portion of the road being already in operation.

It is impossible, in the limited space here available, to go into a detailed description of this great work, and reference should be made to the article above noted both for details and for illustrations of the unfinished work. The difficulties encountered were many and great, especially at important intersections and in the older parts of the city, where pipes, sewers, and electrical conduits were constantly encountered. Obstacles of this nature added much to the cost of the work and caused it to vary much in different localities. It is estimated, however, that the average cost per mile of single track, including excavation, feeders, conduit, and all material employed, has been about $100,000 (£20,000).

The general method employed was as follows. After the street had been excavated for a width of 18 feet 9 inches, a depth for a conduit of 30½ inches, and between tracks of 15 inches, the yokes were placed in position. The track and slot rails, and iron lining of the conduit, were then laid on the yokes, and bolted in place. The tie rods were then inserted, and the whole structure blocked up, surfaced, and lined. The concrete, formed of 7 parts of ¾-inch broken stone, 4 parts of sand, and 1 part of Portland cement, was then placed under and around the iron sheathing, after which the earth was replaced, and the street was repaved. The actual time which elapsed between the opening of a section and street and the time when the track was paved up averaged from ten to fourteen days."

The system provides a complete metallic circuit through the insulated conductor rails,— the track rails not being used as a return,—and the ordinary 500-volt system is employed, the feeders being carried through separate underground conduits at the side of the main conduit.

A notice of the great power station now in course of construction is given elsewhere in this issue, and the entire plant, when completed, will include 59 miles of single track, operated by 70,000 h. p., the whole forming the greatest power plant in use for any purpose.

The Performance of Screw Propellers.

ALTHOUGH the screw propeller is acknowledged to be the best and most efficient device known for the propulsion of vessels, there is yet much to be learned about its performance under various conditions. Many of the ablest engineers and mathematicians have given it their attentive study ; yet in very many instances we find experimental changes necessary before the propellers of new vessels can be made satisfactory, and it is to the results of experiment, discussed in full knowledge of theoretical principles, that we must look for further information.

The most extensive and reliable experiments which have, until recently, been made are those of Froude, published in 1886 ; but these covered only a portion of the problem. A new series of experiments has been inaugurated by Professor W. F. Durand, of Cornell University, and a preliminary paper giving some account of the work was presented by him before the recent meeting of the Society of Naval Architects and Marine Engineers at New York, and published in *Marine Engineering* (December, 1897).

Professor Durand describes the performance of a screw propeller as involving the following features : the work absorbed, the thrust developed, and the useful work returned, the ratio of the first to the last giving the efficiency. The performance depends upon the dimensions of the propeller and the conditions of its use; the former including diameter, pitch, and area, the latter including revolutions, speed of advance, and slip.

After stating the formula for the useful work of a propeller, which is assumed to vary as the square of the dimensions and the cube of the speed, the object of the experiments is stated to be the derivation of data from which values of the factors for any particular propeller may be determined. In these experiments it is intended that the diameter, speed of advance, and shape and number of blades shall be kept constant; while the amount of blade area, pitch or pitch-ratio, and revolutions or slip, shall be varied. In this preliminary paper only a portion of the work has been carried out,—namely, that relating to the effects of change of area. A number of propellers were made, using the same pattern in each case, but paring down the pattern for each successive casting, thus obtaining a series of propellers, identical in all respects except area; with these the experiments were made.

As no experimental tank was available, the apparatus was mounted on the bow of a small steamboat, the propeller to be tested projecting forward into the undisturbed water, and the speed being under control. The propeller was rotated by a small rotary engine, the motion being transmitted by cord and pulleys, and ingenious recording instruments measured the power, speed, and number of revolutions, while the thrust was observed on a mercury pressure column.

The results were reduced to a constant pitch ratio, as well as to a constant number of revolutions, and curves were plotted through the points thus obtained, showing very clearly the relations of area, thrust, slip, and work. Of these diagrams the most interesting is that giving the information especially sought in this especial series of experiments,—the relation of thrust to area.

We know that for a given slip there is some maximum thrust beyond which we cannot pass, no matter what the area. We also know that, when there is no area, there can be no thrust. Starting with zero area, the thrust at first varies nearly as the area, but increases at a slower and slower rate with further increase, until the maximum is reached, after which, for increase of area, the thrust either remains constant or slowly declines. The curves of Professor Durand's tests show that this maximum was reached with an area ratio of about 0.63, but that the change was very slight between the area ratios of 0.54 to 0.72, the tests all being made on a four-bladed propeller, with a pitch ratio of 1.3. The thorough manner in which Professor Durand has carried out and discussed this first portion of the tests gives added interest to that which is yet to come.

American Locomotive Building.

THE success which has attended the efforts of American locomotive builders to establish a market for their engines in countries heretofore considered permanent customers of English manufacturers has caused some interested inquiry on both sides of the ocean, especially as it is understood that the American engines cost less than those of British make, while at the same time the workmen in the United States receive decidedly higher wages. This matter is discussed in an editorial in *Locomotive Engineering* (December, 1897), and some interesting points as to American methods of production are made.

One of the principal reasons for the fact that locomotives can be built cheaper in America than elsewhere lies in the application of Whitney's system of gage and template working to the shop practice. With this came the application of piece-work prices and methods, since duplicate work rendered the piece-work system advantageous both to manufacturer and workman.

"American workmen are so much accustomed to piece-work that very little sentiment exists against it. Piece-work has encouraged mechanics to devise improved tools and perfected methods in doing their work, and the extraordinarily low cost of labor on some machines has resulted from the use of ingenious tools produced by the workmen and patented by the inventors."

"When a machine tool has been put upon the market which promises to reduce the cost of production, the men in charge of every first-class locomotive shop in the country proceed to calculate whether or not it would pay to throw out a good tool to make place for the latest article. They generally decide to purchase the new tool. These are the influences which are giving the United States locomotive builders the markets of the world."

Wages are lower in Great Britain than in America, but the labor product of the American workman is greater in proportion than his wages. A locomotive built in Scotland represents more than twice as many labor hours as an engine built in America, and the cost of the American engine is less, notwithstanding the higher wages received by the men.

As Thomas Carlyle put it many years ago: "*Tools* and the man I sing"; and it is the question of what tools he uses which decides what the man shall do not only with his work, but with himself.

Geared Locomotives.

LOCOMOTIVES in which the motive power of the engines is applied to a number of axles by use of some form of transmission-gearing have been in use for a number of years; especially on the rough logging roads in the lumber regions of the United States such engines have been found most acceptable in service. The idea of driving a number of axles in a train by means of a longitudinal shaft with universal joints, and bevel-gear connections is by no means new, it having been one of the many suggestions made in the early days of locomotive experiment, when it was feared that the adhesion of the engine drivers would not prove sufficient, even on level rails; but, when the success of the Rocket demonstrated the contrary, the geared engine was relegated to obscurity, along with the rack locomotive, until special conditions should appear to warrant its revival. A very full review of some of the later designs of geared locomotives is given in *Engineering News* (December 9), and, in view of the real value of such engines for some purposes, we make extracts.

Geared locomotives, by virtue of their superior tractive power, are especially adapted for use on lumber and mining railways having very rough and light track, with heavy grades and sharp, irregular curves. In engines of this class the entire weight is utilized for traction. Each truck is independently driven, and is at the same time permitted to turn independently,—a combination which permits sharp curves to be passed successfully, while the distribution of the weight over a large number of widely-spaced wheels enables light, roughly-laid track to be used.

Geared locomotives may be divided into two classes, according to the arrangement of the gearing. One form includes engines having outside longitudinal shafts with bevel pinions engaging with bevel wheels attached to the outside faces of the driving wheels; the other style is made with inside shafts, the gearing being mounted on the truck axles. By the use of proper gear ratio the speed of the engine shaft may be increased to double that of the truck axles without causing undue vibration, and thus smaller cylinders used than would otherwise be possible. This feature is of especial value when the slow speed of the logging train is considered, and is another reason for the acceptability of the geared engine in either form for this service. The outside shaft form was the earlier variety of geared locomotives, and many engines of this type have rendered good service, some as large as eighty tons in weight having been built for mountain service. The objections to the outside shaft are the severe twisting strains thrown upon the frames and journals, as well as the exposed position of the working mechanism, and the dripping of oil upon the track.

These defects are obviated in the second type, with central shaft, and some very satisfactory engines of this type have been constructed. Notwithstanding the criticisms of the use of gearing on locomotives, experience has shown that for certain classes of service offers positive advantages. Spur gearing behaves well on electric trolley motors, and the principle of independent axle-driving is there generally accepted as correct. The Heilmann electric locomotive is an example of this method applied on a large scale, and, indeed, one of the especial advantages which is expected to follow the use of electricity as a motive power on trunk-line railways is the distribution of the driving power among all the axles. Ultimately, no doubt, independently-driven axles will be the rule, and not the exception; but, until the more general introduction of electric driving, the geared steam-locomotive will hold its own for the uses to which it is now applied.

A Large Power Plant.

ONE of the immediate results of the development of improved methods of transmitting and distributing power has been the construction of larger power installations than would have been constructed for ordinary industrial operations. In large iron works and similar establishments the total aggregate of power is often very great, but it is generally divided among several centers in order to reduce the inconveniences of transmission.

Probably the largest concentrated power plants in existence, at least until very recently, have been found in the engine and boiler rooms of the great ocean liners, where units of 10,000 to 15,000 h. p. are in use, and where aggregates of 20,000 to 30,000 h. p. have been reached in several instances.

The new power house of the Metropolitan Street Railway Company, in New York, however, will, when completed, be far greater in capacity than any plant now in existence, either afloat or ashore, as it is planned for 70,000 h. p.

A fully-illustrated account of this great power plant is given in *Power* (December, 1897), from which some of the more important data here given have been obtained. Since the sole purpose of the installation is the generation of current for tramway service, the arrangement of the plant is comparatively simple, the generators being coupled directly to the engines, no intermediate transmission being used.

The plant, as planned, is to consist of eleven vertical compound engines, nominally of 4,000 h. p. each, but capable of developing 6,600 h. p. The high-and low-pressure cylinders are mounted on separate columns with the revolving field of the generator on the shaft between them, the generator foundations being provided with rails to enable the outside armature to be shifted to one side, and permit access to the fields for inspection and repair.

The generators will supply an alternating current of 6,000 volts' tension, which will be led at this voltage to substations and there converted into a direct current of 550 volts, by use of static transformers and rotary converters, for supply to the conductors in the conduits.

The boiler rooms adjoin the engine room, and consist of three floors of water-tube boilers, each floor containing twenty-nine boilers of 400 h. p. each. Over the boiler room is a steel storage bin for coal, having a capacity of about 9,000 tons, with chutes delivering coal to the boilers on any floor, the bin being supplied by a conveyor taking the coal direct from vessels at the dock at the end of the building, while ash chutes and conveyors are arranged to remove the ashes mechanically.

Many of the mechanical details of this great plant are worthy of more extended notice than can be given at this time; as the work progresses, further accounts will be forthcoming.

The Armor Plate Board.

THE report of the board appointed by the congress of the United States for the purpose of ascertaining the probable cost of equipping and operating a government armor-plate plant has been discussed at length in the *Iron Age* (December 9 and 16, 1897), and contains much interesting information. Prior to the publication of the report it had been assumed that a plant could be obtained at an expenditure of about $1,500,000 (£300,000), and the question under consideration seemed not so much the advisability of undertaking the construction of the plant, as the determination of the best location for it.

Before deciding upon a location, however, the board undertook to examine into the actual cost of a suitable plant, and secured as expert Mr. John Fritz, undoubtedly the very best man in the United States for the purpose. Mr. Fritz went to work with his accustomed thoroughness, and in a few months produced a detailed estimate for a modern armor-plate plant, showing the cost to be $3,750,000, (£750,000) exclusive of site. While this seems a large sum, the manner in which the estimate has been prepared renders it more than usually reliable. Everyone knows that nearly all public works exceed very materially in cost the original estimates; but, knowing Mr. Fritz's familiarity with the subject, and his experience in similar undertakings, there is every reason to believe that a complete modern plant could be obtained at a figure corresponding to his estimate.

The original cost, however, is not the only matter to be considered. In order to produce armor-plate at a reasonable cost, it is necessary to run the plant at its full capacity, regardless of the demands for armor. The conditions of the economical production of armor plate are not greatly different from those of other lines of industry, and it is only by a full and continuous operation of the plant as a whole, that full operative economy can be realized. This is also necessary if the skilled staff is to be kept up to the highest degree of efficiency, and the latest improvements in the art adopted promptly.

This means that an outlet must be provided for about 6,000 tons of armor plate—equivalent to the equipment of two large battle-ships—every year. If such an outlet is not provided, the full capacity of the proposed plant, which must of course be equal to such a demand in case of need, will ordinarily be far in excess of the requirements of the government.

It is practically this unequal demand for the product which leads private firms to base the price for armor upon the cost of maintenance rather than of actual production, and it is difficult to see how any other method could be followed.

If the government contemplates a continuous construction of battle-ships, until the American navy attains the proportions of that of Great Britain, it is possible that, even at the cost estimated by Mr. Fritz, an armor plant might prove an economical investment. If, on the contrary, the outlet for the product of the plant is to fluctuate with the views of changing administrations and the influences of party expediency, it is hard to see how any advan- is to be gained by the construction of a government plant; and, should the work be undertaken, Uncle Sam may find, as he has already found before now, that he has paid too dear for his whistle.

The Education of Engineers.

THE report of the committee of the Society for the Promotion of Engineering Education upon the matter of the entrance requirements for engineering colleges has brought out some discussion, both editorially and by correspondence, in the columns of the *Engineering Record* during the past month, and the importance of the subject warrants its further notice here.

It is undoubtedly true that the average graduate in engineering does not possess such a general education, or even such a command of the English language, as a professional man should have. Many professional engineers of ability are lamentably incompetent to write a clear report or careful advisory letter, and in matters involving discussion or argument, or the presentation of engineering subjects before committees or organizations, a command of English and a confidence of expression is a valuable auxiliary which too many men lack.

One of the great defects in the preparatory schools is that they attempt too much, or, rather, that they endeavor to teach too many things; as a result, many of the subjects are taught superficially, or even improperly. It is the general testimony of professors of physics, chemistry, and similar branches in technical schools that the preliminary instruction in these subjects given in the preparatory schools is of little or no value. It is much better for the student to devote his time of preparation to English, mathematics, drawing, a general acquaintance with history, and the elements of one or two modern languages, than to spread his energy over a much larger range, including ground which he must subsequently re-traverse, perhaps to get rid of his misinformation. Above all, he should be taught to express himself clearly and effectively, both orally and in writing, and, when with this he has really learned how to study, he may fairly be considered ready to take up the professional portion of his education.

There is one portion of this subject, however, which as yet has not received the attention which it properly demands. In most cases it is considered that a scientific or professional education rather unfits a man for a business career. Now, while an engineer should not be expected to be a business man in the fullest sense of the term, yet the very nature of his work makes many demands of a business nature upon him. How often we find men of high professional attainments earning far less than their abilities warrant, just for lack of the business knowledge and training by possession of which some otherwise inferior man reaps the fruit of the other's skill and labor. It is not only scientific knowledge that should be acquired, but the art of utilizing it as well.

Animated Pictures.

An interesting article in the *Popular Science Monthly* (December, 1897) describes some of the more recent forms of apparatus for the projection of animated pictures, and also adds suggestions for some applications which offer interesting possibilities. Instead of taking the original photographs from ordinary objects in rapid motion, it is possible to make them at much longer intervals, such as hours, days, or weeks, so as to obtain successive views of objects of which the changes occur but slowly, such, for example, as the growth of a plant, or even of a human being. These images could then be exhibited at such a rate of speed as to appear quite continuous, thus exhibiting to the eye the growth of a plant or the blossoming of a flower in as short a space of time as is claimed by any Hindoo fakir, and with far more truth.

" Such views could not fail to produce an effect at once marvelous, unique, and instructive. As pictured upon the canvas, the plants would grow and develop before the eyes of the onlookers, throwing out leaf upon leaf and visibly increasing their dimensions. Here and there a flower or flower-cluster might make its appearance, the individual blossoms bursting forth suddenly, and remaining visible for a brief period only. As object-lessons in botany such motion-pictures would be invaluable, while the general public, not less than the advanced student of science, would regard them with feelings of keenest interest."

But there is another possible application of scientific value and interest. Many phenomena which it is most important to investigate carefully occur too rapidly for the eye to perceive with accuracy, and the study of such subjects is beset with difficulties. Photographed upon a rapidly-moving film, however, the occurrence may be repeated again and again, until all its details have been observed, and, as the rate of speed of the projecting film may be reduced, the critical point of the phenomenon may be caught and identified.

For example, a piece of metal may be placed in a testing-machine and a continually-increasing stress applied until the elastic limit has been passed and the point of rupture reached. During this entire time a continuous film might be filled with photographs, constituting a complete visual record of the test, which could then be examined at leisure at as much slower speed as desired, any number of times, and, by comparison with the graphical record of stresses and strains, add materially to our knowledge of the subject.

These are but isolated examples of the possibilities of the cinematograph as an instrument of scientific research and other applications will readily appear.

THE BRITISH PRESS.

English and American Freight Cars.

ONE of the important factors in comparing the cost of production of manufactured articles in England and the United States is the relatively lower cost of freight transportation in America over that in Great Britain.

An article in the *Iron and Coal Trades Review* (December 17, 1897), in discussing this subject, calls attention to the much larger size of the American freight cars, and shows the great economy resulting from the use of large cars. In England nine to ten tons is the maximum capacity of goods-waggons, while in the United States the capacity of cars has been increased between 1876 and 1881 from 20,000 to 40,000 pounds, with an increase of only 1,500 pounds in the dead weight, the increase corresponding to a gain of more than 15 per cent. in the paying carrying-capacity. During the past few years a still greater increase has been accomplished, and cars have been made in some cases of as great capacity as 40 to 50 tons especially for the ore carrying trade

After giving some illustrations and description of large American steel freight cars, and noting the various elements of economy in repairs, resistance, and care, in addition to the increased carrying-capacity, the writer proceeds to urge the question of larger cars upon the managers of British railways.

" If in this country (England) we cannot cheapen the cost of our railways, which stand at the unprecedentedly high capital value of £50,000 ($250,000) per mile, we can at any rate cheapen the cost of working them, and in this direction our railway managers are likely to give increased attention to the building of larger and lighter cars. If by this means they can reduce the tare on mineral traffic by only 20 per cent., they will have done a good stroke for economy, but, in the light of American experience, better results than that should be possible."

Foreign Machinery in England.

THERE has been some correspondence in the columns of recent issues of *Engineering*, bearing upon the subject of the influx of foreign machine tools into England, which expresses more clearly the real condition of affairs than anything else yet published. Referring to the reason why the travelling salesman from America is received and welcomed by the English purchaser, one correspondent remarks: " The traveller from the States offers machine tools of a class such as are not produced in Great Britain. As an instance, I will take an industry with which I have no connection—the bicycle trade. At the present time thousands and thousands of pounds are going to America for automatic tools to make bicycles. This is not because bicycle makers hate their own countrymen, but because they positively cannot get these ingenious and beautifully-made machines at home. The cycle trade is crying aloud for machinery ; makers are in despair because they cannot get it for their spring order work, and yet England cannot fill the gap—no, not even Manchester ! Yet the cycle had its origin in England, and was a large industry here years before it was much more than thought of in America."

A number of instances are also cited in which English firms practically declined to undertake the construction of special tools, while the representatives of German firms investigated the matter and designed and built special machinery for repetition work under guarantee, securing the original and subsequent orders.

Another correspondent puts the case still more strongly. Says he : " The fact is, the average machine-tool maker is a kind of Rip Van Winkle. He has been asleep for twenty years, and it is only recently that he has been roused. Even now he is not fully awake, and he finds the bustle of the modern world very annoying. He would like to hush it into a state of repose more congenial to his feelings, and so he sends to the papers some recollections of the past, and calls them 'Suggestions for the Future.' It is a future which will never be realized."

The American salesman's method of doing business also comes in for a share of notice.

"He thoroughly understands his business, and has plenary powers to conclude a bargain. He can pick up a piece of work and say: 'I will guarantee to make you a machine to turn out these at so much a dozen, and the price will be so much.' The Englishman says: 'I will make a note of your requirements, and our firm will write you on the subject.' What is the use of taking a commercial traveller into your works? You can get no ideas out of him, and the ideas you put into him get sadly changed before they reach his principal. We don't take strange Americans into our confidence because we love them, but for the sake of what we can get out of them; and we don't pay them more than we can help."

Maltese Architecture.

A RECENT paper before the Royal Institute of British Architects by Mr. Arthur S. Flower, entitled "Notes on Renaissance Architecture in Malta," contains much that is of interest and value in connection with renaissance architecture in general, and in relation to the buildings of the Order of St. John in particular. As Mr. Flower truly says, most people think of Malta as little more than a British military station, and possibly as at one time the headquarters of the Knights Hospitallers, though, as a matter of fact, the little island teems with huge buildings, the product of many centuries of activity and ambition.

Owing to the abundant supply of an excellent and easily-worked building stone, the buildings of Malta furnish examples of most admirable masonry construction, and, because of the ease with which the material could be carved and the abundance of skilled artist stone-cutters, many of the buildings show a richness of detailed ornament rarely found elsewhere. Mr. Flower says: "I have been several times assured, on credible authority, that, even down to our own days, the custom in Malta as regards masonry has been that carved work, however elaborate and varied, was never reckoned or separately charged for in building contracts, but thrown in as a matter of course, and rather by way of pleasure to the workmen. And yet this Maltese stone, so fascinating to handle, weathers, as a rule, so excellently that three or four centuries seem to make no damaging impression upon the fine-wrought ashlar with which every building, great or small, is clothed."

The principal building which Mr. Flower describes and illustrates is the cathedral at Valletta, the capital and largest town. This is an excellent example of the renaissance architecture of the middle of the sixteenth century, modified by the conditions of the order, and also greatly benefited by the use of genuine carving instead of the flimsy stucco so much in evidence in Italian buildings of the same period. The peculiarities of the building lie mainly in the proportionally less height of the arched roof of the nave, and also in the arrangement of side chapels for the branches of the order in different countries.

The characteristic features of Maltese architecture were well brought out in the discussion on the paper. Among the speakers, Col. Prendergast remarked that, "in discussing these things one often failed to recollect the purpose for which these buildings were erected. They were not erected in order to make merely a pretty church;—this proceeding had been left to the Victorian era;—they were built for a specific purpose. There were half a dozen or more—seven, he thought in all—*langues*,—*i. e.*, lodges of the order,—whose business it was to deal with the work in different countries, and this church was merely a series of chapels; the *langue* of each country having its own chapel, which opened into a spacious hall with a barrel vault over it, and this was the nave of the church; but the *raison d'être* of the whole building was this series of chapels."

An interesting feature about the renaissance work in Malta is the evident influence of the nationality of the grand masters of the order upon the style of architecture, and especially of decoration. The several Spanish grand masters, of whom there were several in succession, brought in Spanish ways, and Spanish balconies can be found affixed to Italian buildings, while in other structures Spanish influence can be seen very plainly. During the following century the last grand masters, who came from France, introduced French details, and thus the various nationalities, one after the other, impressed in some degree their artistic feeling upon the buildings of the order, the fundamental style, however, always being that of the Italian architects and workmen.

Altogether, Mr. Flower has called attention to a phase of renaissance architecture which has been too much neglected, and which might be studied by modern architects with undoubted advantage.

Incandescent Gas Mantles.

In view of the extending use of the incandescent system of gas illumination and the unequal illuminating power which has been experienced with mantles of various kind, any really scientific investigation into the relative value of different mantles is a welcome addition to our stock of technical information.

An interesting report of a number of tests of such mantles is given in the *Electrical Review* (December 10)by Mr. E. A. Medley, with much valuable information in general about incandescent gas lighting. Mr Medley had made some tests on mantles of the Incandescent Gas Light Company's mantles in London as long ago as 1893, and these he refers to as showing the improvement which has been made since that time. The tests referred to in the present report were made in Berlin, and include not only the two English mantles of the Sunlight and the Incandescent Gas Light companies, but also those of the German concerns, including *Die Deutsche Gasglühlicht Aktiengesellschaft*, *Die Neue Gasglühlicht Aktiengesellschaft*, and the *Stabil Mantel.*

The standard of light used was the Heffner amyl-acetate lamp, in connection with a Lummer-Brodhun photometer, the gas being measured by an Elster experimental gas meter. Much care was taken to secure uniform and reliable results, the room being thoroughly ventilated, and draughts at the same time avoided, as it has been found that the light is materially affected if there is not an ample supply of fresh air. The horizontal candle power was measured in three directions, 120° apart, and the mean taken as the correct reading, the measurements being taken every twenty-four hours. The details of the tests are given in full in the paper, and we can here give only the final table, which contains practically all the important results; it will be noticed that one of the German mantles, the Stabil mantle, is decidedly superior to any of the others, either English or German.

Make of Mantle.	Candle Powers.			Percentage fall in.	
	New.	100 hrs	500 hrs.	100 hrs.	500 hrs.
Sunlight Company.. .	36	33.4	14	7	61.2
Incandescent Gas Light Company...	52.9	49	29.7	7	43.8
Deutsche Gasglühlicht Aktiengesellschaft..	70.3	49.7	28.2	29	59.9
Neue Gasglühlicht Aktiengesellschaft..	53.5	40.3	33.3	25	37.7
Stabil Mantel	62.6	57.1	47.5	9	24.1

An important feature in connection with incandescent gas burners is that of the proportion of the size of the mantle to the Bunsen burner. In many cases the mantle is much too large for the burner, and, in consequence, does not become properly incandescent all over; it also shrinks and warps out of shape to a much greater extent than when smaller. Tests also showed that the light absorbed by mica chimneys as compared with glass ones was as much as 9.4 per cent.

Mr. Medley's general conclusions are summed up as follows:

"The mantles give a wonderfully good light when new, but the extreme rapidity with which the light falls off, and the consequent shortness of their efficient life, even when treated with every consideration due to their somewhat delicat constitutions, makes them far from an ideal illuminant. With the possible exception of the Stabil mantles, a great deal of improvement is necessary before, for domestic lighting at any rate, they can be considered even satisfactory."

To us this conclusion seems rather too sweeping. It is undoubtedly true that there is room for much improvement in mantles of all makes, but, when we see, by Mr. Medley's own tests, an average light of 50 candle power produced by a consumption of only 4 cubic feet of gas per hour, even an efficient life of 500 hours is not too short; and when, as he suggests, the price of mantles is likely, upon the expiration of the Welsbach patents, to fall to less than 4 1-2 d. each, which is now the price for good mantles in Berlin, the question of the life of the mantle will become a matter of minor importance.

Healthful Buildings.

MODERN investigations into the causes of disease and the best methods of disease-prevention have led us to look for sources of ill-health in many places formerly neglected. This is especially the case in connection with house-building, and there are many apparently minor details in connection with building construction which have an important bearing upon the health of the occupants.

The Sanitary Record (December 10, 1897) contains an excellent discussion of this phase of building construction, by Mr. Peter Fyfe, whose position as chief sanitary inspector at Glasgow gives him abundant opportunity of knowing whereof he speaks.

Speaking especially from the standpoint of the carpenter and joiner, Mr. Fyfe says: "A healthy house must, firstly, be dry in every part; secondly, it must be able to be thoroughly cleansed throughout; and, thirdly, it should leave no facilities within the four walls for the harbouring of infective or other dust."

The protection against dampness is mainly to be found in the work of the mason, and, unless a real damp-proof course is put in the walls, or if a damp site is not protected by a layer of concrete or asphalt, the work of the joiner becomes seriously affected. Not only wood, but also bricks when exposed to dampness, become the prey of fungi and moulds, producing rottenness and disintegration.

A frequent source of foulness in cellars and lower floors of buildings unprovided with concrete or asphalt coverings is the access of ground air. Many sites which seem dry and comfortable to the eye may discharge large quantities of ground air into cellars and similar spaces, owing to the rise and fall of ground water beneath. This ground air contains a large proportion of moisture, and speedily causes decay, and possibly disease.

One point especially emphasized by Mr. Fyfe is the reprehensible practice of covering up damp walls and partitions with woodwork, and thus endevoring to conceal the evil which, instead, should be eradicated. This is also true of all woodwork formerly so extensively used to enclose plumbing around sinks, baths, and water-closets; the removal of this useless work also conforms to the second and third conditions,—as to the facility of cleansing and the removal of dust lodgments.

Among the various obnoxious dust-holes Mr. Fyfe is especially severe upon the enclosed lofts and roof-spaces so common in many houses, more particularly those having peaked or sloping roofs. These spaces form storehouses, not only of microbes, but also of close, stuffy, and contaminated air, and are often constructed without openings for light or ventilation,— conditions under which cleaning is an utter impossibility. The remedy for this state of affairs may be found in the adoption of the flat roof which both eliminates the dusty cavern, and provides an area for a playground or space for washing.

The sliding sash window also comes in for a share of condemnation. "Here we have a long, hollow box for the weights, which in time becomes a dust chamber, and one peculiarly situated in the direct line of the air-supply to the room. It must not be overlooked that through the chinks left all around our windows the large proportion of the fresh air to the room enters; and incoming air should not, if practicable, be caused to pass through or over any chambers or hollows where dust and dirt, to say nothing of fungoid growths, are permitted to lodge." The French hinged windows are free from most of these objections, or, at least, can be made so more readily than the sliding sash; and, besides, they admit of the outsides of the windows being cleaned from the inside of the apartment.

Another place for the lodgment of dirt is the picture moulding now so generally found in residences, nailed around the wall to permit the hanging of pictures without the necessity of driving nails into the plaster. "This forms a very comfortable situation from which myriads of microbes may select their time for pouncing down on the unsuspicious tenant. In ninety-nine cases out of a hundred, on inspection, this elongated dust-shelf will be found completely covered with the germs, mixed up with all the inorganic *débris* continually floating about in our atmosphere.

"Surely a room can be made quite æsthetic-looking without resort being had to such shelvings and crevices. Hygienic conditions and æsthetic conditions should, if at all possible, meet and go together, the one helping the other; and, I think, if joiners, plasterers, and other tradesmen set their minds against encouraging shelvings of this kind, we would have sweeter and cleaner houses than we have at the present time."

English and American Machine Tools.

IN an interesting article entitled "Some Lessons of the Stanley Show" (*Engineering*, December 3, 1897) Mr. Joseph Horner institutes between English and American machine tools comparisons which are especially in point at the present time. The special tools exhibited at the show by the American builders of machines for bicycle-making form the principal subject of the comparison, but the facts apply equally well to many other lines of work.

After describing some of the tools at the Stanley Show, and noting the many points of excellence possessed by the American machines, Mr. Horner proceeds:

"Of course one cannot suppose that American engineers and mechanics are more richly endowed with mechanical genius and skill than ourselves. But other qualifications than these are essential to success in a time like the present, when England is but one section of the world's workshop. Such qualities as these are of equal value, and, under similar conditions of mechanical skill, will turn the scale. One of these qualifications is to study the precise wants of users of machinery and tools, and to cater for those wants as carefully as possible, unhindered by preconceived ideas and conservative prejudices. This method involves not only questions of general design, but also the working out of an almost infinite number of minute details, including accessories, feeds, and movements, both for saving time and conducing to efficiency of results; details which have their highest development now in the numerous automatic machines which do everything but talk, and which are at once expeditious, accurate, and self-attending.

"The second condition is that the thought of finality must give way to that of progress. There is no machine which is so good but that it may be improved upon. If any real improvement is seen to be possible, then drawings, patterns, stamps, and special tools must be altered or re-made, so that the best possible results are secured thereby.

"The more highly developed, the more complicated, a machine becomes, the more perfect must its workmanship be. This involves the design of the most perfect machine tools and small tools for the production of this perfect work. And, inasmuch as this is only possible financially by the sale of a large number of machines, it further includes the adoption of a perfect shop system, or that under which interchangeability of parts is secured, while the actual cost of labour on any single piece is almost infinitesimal—a fraction of a penny in some cases, in others a few pence or cents only.

"In these cardinal matters English methods and American methods differ substantially. We are conservative in method; they are alert and progressive. We tread in time-worn grooves; they seek more excellent ways. We do not adopt the interchangeable system to the same extent as they do. American shops are becoming increasingly specialized, and to a much greater extent than English ones. There are few firms in America like Messrs. Tangyes, for instance, in England, who manufacture machine tools, cranes, engines, pumps, boilers, and many other articles. The number of those who are engaged in the general machine-tools trade, like Messrs. William Sellers & Co., is not large. Many of the firms confine their attention chiefly to a few tools only. The consequence is that there is no finality in design thought of. Improvements are being constantly introduced, and the special machines, the products of particular firms, become as well known by names and numbers as the Whitworth threads or the Morse tapers."

Mr. Horner then goes on to discuss the merits and capabilities of many of the special tools at the show, the comparison in every case being wholly favorable to the American tools, and concludes by saying:

"Much more relating to the subject suggests itself to the mind, but this must suffice. These lessons of the show should be laid to heart by the great English firms, rich in capital, in prestige, in skill. In other directions there are not wanting indications that English manufacturers will be hard pressed in the near future. But one lesson is enough to learn at one time."

A Power Gas Plant.

THE improvement in gas engines, and especially in producers for the generation of power gas for use in gas motors, is a noticeable feature of current engineering progress, and we constantly hear of installations of gas producers and motors in fairly large units which generate power for industrial purposes at costs far below any figures possible with even the best steam-power plants.

A note in the *Iron and Coal Trades Review* (December 3, 1897) gives interesting information of a power gas plant recently installed at the establishment of Messrs. Porrett & Sons, at Burstall, near Leeds.

The generator used in this case was the form known as Thwaite's Continuous Cycle, which has no steam boiler, but is supplied with air from a fan driven from the main engine. The entering air is preheated by a regenerator, through which the hot gases pass on leaving the generator, about 20 per cent. of the heat in the gases being thus returned. The hot air absorbs moisture from the water in the hearth of the generator, which passes on with the air through the fuel-bed and increases the proportion of hydrogen in the gases. Several analyses of the gases under different conditions of working give average results as follows:

THWAITE'S GENERATOR GAS.

	Percentage composition by volume.		
	Coke only in generator.	Coke, with coal slack.	Coke only but dry hearth.
Carbonic acid CO_2	3.1	5.2	2.8
Carbonic oxide CO	28.0	24.0	28.2
Hydrogen H	5.8	7.4	4.1
Marsh gas CH_4	2.1	1.4	1.8
Nitrogen N	61.0	62.0	63.1
Total	100.0	100.0	100.0
Thermal value cu. ft.	132.0	116.6	125.0

The above thermal values are computed per cubic foot at 32° F., down to 212° F., in British thermal units. The volume of gas per ton of fuel was about 181,440 cubic feet, at 32° F. The thermal value of the fuel used, as determined by the Thompson calorimeter, was as follows:

	Coke.		Coal Slack.
	I	II	
British thermal units per lb.	13,850	13,889	12,913

Volatile matter, 25 per cent.

The engine in which the gas was used was built by Hartley & Petyt, and worked on the Otto cycle. There were two cylinders, each 16 by 24 inches, arranged side by side, giving an impulse every revolution, the speed being 140 revolutions per minute, and the mean effective pressure ranging from 71 to 88 pounds per square inch.

The tests were made under ordinary working conditions, and the power varied very much, according to the demands of the machinery, ranging from a very light load up to 150 h. p. in a few revolutions. The average indicated power during the day was about 70 to 80 h. p. and the actual weight of fuel consumed amounted to only about 112 pounds per working hour, the consumption of gas ranging from 80 to 87 cubic feet per h. p. hour.

Taking the richest value for the thermal power of the gas, and assuming the higher figure for gas consumption, we have a minimum efficiency of more than 22 per cent., which is certainly a very creditable performance; and the fact that the fuel may largely consist of coal slack requires that the economy of cheap fuel also be considered in determining the commercial efficiency.

The possibilities of this method of generating power, and especially the advantage of using gas producers which will gasify the lower grades of slack without choking, cannot fail to attract the attention of all engaged in the search for cheap motive power; and, with cheap gas made from cheap fuel, used in economical motors, we may find a source of power which will compete favorably with hydraulic power, especially when first cost of plant is considered.

The Theory of the Centrifugal Pump.

THE centrifugal pump is a machine which, more perhaps than almost any other, has been constructed according to empirical methods and upon proportions determined rather by experience than from theoretical considerations. Professor Rankine, it is true, has given the subject attention, but his method has been but little used, and the leading makers in England, Messrs. Appold and Messrs. Gwynne, as well as the principal constructor in France, M. Farcot, have followed empirical lines and proportions based upon experience.

A valuable paper read December 6, before the North-East Coast Institution of Engineers and Shipbuilders, Sunderland, by Mr. C. H. Innes, gives in a very clear and practical manner the mathematical principles upon which the performance of centrifugal pumps and fans depends, and shows the action of different shapes of vanes, diffusers, and discharge pipes.

Mr. Innes calls especial attention in his paper to the theoretical discussion of the subject by Prof. Rateau, of the School of Mines at St. Etienne, and shows that with the Rateau form of vanes a high manometric power can be attained with fans, and a corresponding pressure in the case of pumps. The Rateau fan is based on the fundamental principle that maximum efficiency may be obtained by avoiding sudden changes of direction and velocity and, as far as possible, curvature of path and surface friction, and discharging the air with as low a velocity as possible.

In the Rateau fan the curvature of the vanes is so proportioned that the relative velocity of the air between the vanes either remains constant or increases slightly from inflow to outflow. The casing contains the diffuser and the volute; the diffuser increasing slightly in width from inflow to outflow, being spiral in form instead of circular, and forming a volute the cross section of which depends not only upon the angle of rotation, but also upon the number of cubic feet of air or water delivered per second.

The paper discussing this portion of the subject, while mathematical in treatment, is not at all obscure, and the correctness of the deductions is well shown by the close coincidence of the computed heads with those determined by experiment.

A table of proportions of the Rateau fans is given, by use of which the correct shape of the vanes, diffuser, and volute may be found at once for any desired capacity and for large, medium, or high pressures, and the whole paper places the data for the design of fans and centrifugal pumps within the reach of the practising engineer in a far more complete manner than heretofore.

Inland Navigation.

NOTWITHSTANDING the superlative importance of railway communication, the older and slower canal system still holds its own in many places. On the continent new canal projects are continually being reported, while in the United States the enlargement of existing canal systems is a fruitful theme for discussion.

The question of inland waterways in Great Britain has in recent years not received the attention which its importance demands, and in a leading article in *Industries and Iron* (December 3, 1897) the subject is revived and some strong points made in favor of inland navigation improvements.

Inland water transport can be made to pay, and to pay well, if a combination system is worked out on a sound basis and the traffic efficiently conducted. Even in the present imperfectly-worked systems those canals which are not dominated by railway influence are worked at a profit, and some of the old-time canals which are practically in the primitive condition that they were in when made at the end of the last century are successfully holding their own in the face of the competition of first class main-line railways equipped with every modern appliance.

This is largely due to the high cost of goods transportation in Great Britain by railway as compared with other countries, the rate per ton-mile in England being 75 per cent. higher than in Belgium and 350 per cent. higher than in the United States.

It is as an auxiliary to this quicker, but more expensive, method of transportation that a properly-organized canal service can render its best aid. Says the author of the article quoted, Mr. Perry F. Nursey: "If a systematic development of our waterways is to be undertaken, as a preliminary step the railway companies—especially those which own canals—will have to be approached, and persuaded that a system of properly-constructed canals would act as an auxiliary to their lines, and not as a competitor. It must be demonstrated to them that the two could really be working together with advantage, minerals and other heavy goods being sent by water and lighter commodities by rail."

Many of the objections now made against canal transport may be met by the introduction of improved methods. The delays due to locks can be obviated to a great extent by the use of hydraulic or pneumatic lifts, while increased speed can be secured by the installation of steam or electric propulsion.

According to the figures given by Mr. Wells, an engineer possessing an extensive acquaintance with the subject, transport by canal is much more extensively used in competing countries than in England. In the United States 27½ per cent. of the traffic is water-borne, in France 30 per cent., and in Germany 23 per cent., while in England it is less than 11 per cent.

"The present function of British canals is mainly to keep down railway rates. However useful this function may be, it falls far short of that standard of usefulness which they could be easily made to attain. They possess great possibilities which only require developing. Modified and improved in detail, they could be made to effect a reduction in the cost of carriage of heavy goods to a point far below anything which can be attempted by railways, unless, indeed, their present charges are inordinately in excess of what they should be. But, in order to secure these benefits to their fullest extent, numerous constructive details will have to be altered and the canals themselves modernised, as well as the craft plying upon them. The sectional area of the water-ways must be increased, and bridges must be widened, to allow of larger bottoms being employed than at present in use. Mechanical propulsion must be substituted for manual and horse labour, and modern facilities for the transfer of goods must be introduced. With these improved conditions, a modernised administration, and the establishment of regular services, the cost of water-conveyance could be very largely reduced. Unused canals could be made to show a good return, whilst those which now pay would pay better."

THE CONTINENTAL PRESS

Utilization of the Power of the Arc.

THE river Arc is a small stream which has its origin in the French Alps, flows as a mountain torrent through Savoy, and discharges into the Isère. Its rapid fall renders it peculiarly available for motive power, and a number of important power installations have recently been constructed at points along its banks, developing electro-chemical industries of considerable magnitude.

A general account of these works is given in *La Revue Technique* (November 25, 1897); it is worthy of attention, both from the electrical and the commercial standpoint.

The first plant of any present interest is at La Praz, where there is now a large establishment using some 3,000 h. p. for the electrical reduction of aluminum and the production of calcium carbid, and, when the works now under construction are completed, the capacity here will be increased to 13,000 h. p.

The construction of the hydraulic portion of this work is typical of the country. About two miles above the town a sort of dam is formed in the stream by some boulders, piled in the channel and permitting the water to be diverted into a basin formed in masonry, where a certain quantity can be stored, and where the sand and gravel carried by the swift torrent are deposited, instead of passing on to wear and injure the turbines. Even with this precaution much sand is carried through and the wheels hardly last longer than six months when operated continuously. The water then passes to a sheet-iron pipe 6½ feet in diameter, in which a fall of 115 feet is obtained in about a mile, with a flow of 247 cubic feet per second. The turbines are arranged on vertical shafts in units of 700 h. p., the dynamos being coupled directly to the turbine shafts. One of these generators is noteworthy from the fact that it is the largest unipolar continuous current machine yet built, having an output of 15,000 amperes, at 40 volts. At first some trouble was experienced from heating, but with proper ventilation this difficulty has been overcome, and the machine is now used with much success in electro-chemical work. At La Praz the production of aluminum is about one ton per day of the metal, either pure or in alloys. The new works, by which 10,000 h. p. is to be added to the capacity, involves the construction of a tunnel nearly a mile long, which will enable a volume of 420 cubic feet per second, with a fall of 246 feet, to be utilized.

About six miles further down the stream a contraction of the channel causes the formation of rapids, and here is placed an electro-chemical works devoted to the manufacture of chlorate of potassium, chlorate of sodium, and calcium carbid. Here about 4,000 h. p. of water is conducted through a tunnel over a mile long, and acts upon twelve turbines of 200 h. p. each, and four of 400 h. p., the wheels being arranged on horizontal axes, with generators of the Thury type mounted on the same shafts.

The production of calcium carbid here is as yet only experimental, but the electrolytic production of chlorate of potassium and of sodium by the decomposition of the respective chlorides forms an important industry, reaching over a ton per day.

Still farther down the stream the so-called Calypso works is reached, situated in a most picturesque valley between high rocky mountain walls; and here 2,500 h. p. is harnessed and utilised in the manufacture of aluminum. The output is about 2,200 pounds per day, so that it takes a little more than one horse power to produce a pound of aluminum in twenty-four hours, or as tests have shown, 309 grains (20 grams) per horse power per hour. Plans are now under consideration by which 12,000 h. p. will be utilised a short distance further down, so that before very long nearly 32,000 h. p. will be taken from this comparatively insignificant mountain stream within a length of a few miles.

When it is considered that Upper Savoy and Switzerland contain innumerable streams of this sort, the capacity of the region of "white coal" for power generation in competition with the land of grimy collieries will be seen to be a matter worthy of respectful consideration.

River Gagings in France.

In considering the question of river improvement and the many dependent problems, it is of the utmost importance to be able to estimate, at least within certain reasonable limits of accuracy, the volume of water to be handled, and also to have some knowledge of the maximum and minimum flow for any given case. This question is so involved with metereological and physiographical conditions that it is very difficult to establish any definite relation between the flow of a stream and the area of the basin which it drains, although many attempts have been made to do so. The best method, whenever possible, is to make careful gagings of existing conditions and use these records for cases in which, in the judgment of the experienced engineer, the relations of area, slope, and other geographical features are similar.

A very careful study has recently been made of the statistics of these points in connection with the principal rivers of France by M. Bresse, and published in the *Annales des Ponts et Chaussées* (*3e Trimestre*, 1897), and the data thus compiled, together with the theoretical discussions of the various points, form a valuable contribution to the important subject of river improvement and stream flow.

The rivers of France have been a subject of scientific observation for many years, the records for the Seine having been kept from the beginning of the present century and for other rivers for many years, and hence the statistics of high, low, and average flow are sufficiently complete to permit fairly reliable conclusions to be drawn. In connection with the measurements of the volumes of water discharged by the various rivers at different points, the area and nature of the basins drained have been studied, as well as the effects and durations of floods, so that the whole mass of data thus accumulated furnishes material of exceptional value.

In a great number of cases the volume of flow and the height of water have been measured for a sufficiently great variety of conditions to enable curves to be plotted from which the flow for any given height can be deduced at once, and in most cases these curves can be included in the parabola of the form:

$$Q=A+BH+CH^2$$

in which Q is the volume of flow; H, the height of water on the local scale; and A, B, and C are constants determined by observation.

Curves for nearly all the principal rivers of France as well as some for Belgium have been plotted, and are given in the paper of M. Bresse, and these enable valuable comparisons to be made, especially when the local surroundings of the various streams are taken into consideration.

It is impossible in this place to go into the details of the numerous gagings which M. Bresse has tabulated and discussed; for these, reference must be made to the original paper; but many of his comments will be of value in connection with gagings elsewhere. In many cases the measurements made with floats or with the Woltmann mill may be used to correct the coefficients to be used in the hydraulic formulæ which give the mean velocity in terms of a function of the slope, but these formulæ can only be relied on in cases in which the movement is of a permanent nature, or where the channel is controlled by dikes or quay walls.

M. Bazin has shown that very accurate results may be obtained by the use of weirs, when applied to small streams, but attempts to compute the flow in a similar manner for larger rivers, even when suitable dams were available, have not been equally satisfactory.

The Woltmann mill, in some of its improved forms, has the great advantage of permitting the direct measurement at each point of the cross section of the stream, and avoids the use of a coefficient which must be more or less arbitrary. It is, however, rather inconvenient to use, especially when the current is at all strong; and the amount of time required is often an objection to its use, particularly when the level of the stream is rapidly changing.

When the level is very high or the velocity great, as at the time of floods, the only practical method is the use of floats, the time being accurately noted for a float to pass a measured distance. Surface floats offer undoubtedly the simplest means of determining the velocity of a stream, the only objection to them being the necessity of using an arbitrary coefficient representing the relation of the surface velocity to the mean velocity of the whole section. This coefficient is generally taken as 0.80, *i. e.*, the mean velocity is assumed to be equal to 80 per cent. of the surface velocity. The experiments of Bazin have shown that this value is rather too low and that it varies between 0.83 and 0.87, so that in general it should be taken as about 0.85, with but small probability of error.

Immersed floats, in the form of weighted rods, have been advocated as a means of obtaining the mean velocity directly, but it is difficult to be sure that the conditions of immersion are always such as to give the true values, and, in the opinion of M. Bresse, the error resulting from the use of such immersed floats is apt to be greater than that involved in the use of surface floats, taking the coefficient 0.85 as the ratio of the mean to the surface velocity.

In a note annexed to his report, M. Bresse describes the method used by M. Sainjon in computing the discharge during the great floods of the Loire, based on the time required for the high water to be attained at two points a known distance apart, and a comparison is made between his formulæ and those used by the Italian engineers in similar cases. The formulæ of M. Sainjon are shown to give similar results to those of Tadini, and are not greatly different from the measurements made on the Po.

The Müngsten Viaduct.

THE country around Düsseldorf is one of the busiest and most densely populated portions of Germany and contains numerous towns which are well known by their products in all parts of the world. The names of Elberfeld, Barmen, Solingen, and Remscheid, are connected with manufactures which have carried the mark "made in Germany" to many countries, and in many ways the mechanic arts have arrived at a high degree of efficiency in this part of Europe. The two towns of Solingen and Remscheid, however, have not been connected by railway except in a very indirect and roundabout manner, on account of the deep valley of the Wupper between them. The railway station at Remscheid lies over 300 feet above that at Solingen, while the level of the Wupper is more than 300 feet below the latter, and until recently the cost of bridging this valley has prevented the construction of a direct road, so that, although the distance is only five miles in an air line, the nearest way by rail has been over twenty-seven miles.

For a number of years various plans for bridging this valley have been considered, and now that the work has been accomplished the history of the whole subject, as well as a very complete account of the viaduct as constructed, is given by Herr Rieppel with many illustrations, in the *Zeitschr. des Vereines deutscher Ingenieure* (November 20, December 4 and 11, 1897).

Among the original plans submitted were included several forms of braced arch for the main span over the deepest portion of the valley; a trestle viaduct, somewhat on the American style; and a cantilever, but the design as finally adopted consists of a fine parabolic braced arch of 524 feet, 11 ins. clear span (160 meters) with trestle approaches. The clear rise of the arch from the springing of the inner chord to the under side at the crown is 225 feet, while the height of the roadbed above the surface of the Wupper is 349 feet.

The manner in which this great work was conducted offers some points of interest, and is shown very clearly in Herr Rieppel's account. No false works were used to support the incomplete structure, the two halves of the great arch being suspended by cable work from the trestles on each side, much in the same manner as was adopted by M. Eiffel in the construction of the Garabit viaduct. A temporary trestle bridge was built across the stream at the level of the springing of the arch, and an inclined cableway conducted down each side of the valley so that material could be delivered at any point along the line of the viaduct at the surface of the ground. As the trestles increased in height the material was elevated by means of cranes, and when the projecting halves of the arch were begun the lateral tension was sustained by cables carried along the horizontal trusses and anchored in the rocky hillsides; until the ends of the arch met at the crown and the entire structure became self supporting.

The trusses for the main roadway were assembled on horizontal trestles directly beneath their respective locations and then hoisted bodily to the level of the roadway above, thus reducing the detailed work aloft to a minimum. Herr Rieppel's account shows the progress of the work in this respect very fully by means of photographs taken during the course of construction, forming an excellent record of the manner in which the viaduct was constructed.

The main arch was constructed without hinges, the springings also forming a portion of the bases of the main trestles; but the main roadway trusses were placed entirely above the arch truss, the bottom chord of the road truss being on the same level as the upper rib of the arch. Notwithstanding the magnitude of the work the whole effect of the completed viaduct is most graceful and artistic, the work enhancing rather than defacing the beautiful scenery with which it is surrounded.

The completed viaduct was subjected to a thorough test by a load consisting of three of the heaviest freight engines and forty loaded cars. The greatest deflection measured was a trifle over 15 millimeters, and there was not the slightest indication of any permanent set.

Pompeian Restorations.

THE remains of Roman architecture which have been partially preserved for us at Pompeii have been the subject of much study and discussion, but it is probable that no such systematic attempt has been made to restore the architecture of the buried and exhumed city as that recently completed by the Leipzig architect, Professor Weichhardt. For a full account of the work which he has done in this interesting historical and architectural field, reference must be had to the magnificent volume recently published, but a very fair idea of the manner in which the city as it existed before the fatal eruption has been restored by Prof. Weichhardt, may be obtained from the extracts from his book published in various journals, of which accounts we may cite, as most complete, that appearing in the *Schweizerische Bauzeitung* (November 20, 27, December 4, 11, 1897).

In order to make an intelligent restoration of these ruined buildings something more than a mere familiarity with Greek and Roman architecture is necessary, since the judgment of the trained archæologist is often necessary in order to determine from the broken capital or the nature of the intercolumniation just what period or style was possessed by the temple or building of which only the brick core and a few fragments of the exterior finish now remain. There is often a kind of instinctive genius in this sort of work, which enables the enthusiastic archæologist to feel as it were the spirit of the original constructor, and to proceed with his work with much the same certainty as a Cuvier or Owen in the restoration of a mammal from a tooth, or of an Agassiz in the reconstruction of a fish from a few scales.

Professor Weichhardt has certainly done his work well, as any student of architecture will realize when he compares the drawings of the existing remains with the restorations of the same buildings as shown in the illustrations of the articles to which reference has been made.

The views of the Triangular Forum, with its ancient Greek temple; of the

Temple of Jupiter and the Public Forum; and especially of the very effective drawing of the restoration of the Temple of Augusta Fortuna; all these show the spirit of the artist-archæologist in a manner which must be seen to be fully appreciated.

It is in painstaking work of this kind that the industrious attention to minute detail which is so characteristic of the German specialist shows to the best advantage. It is at Pompeii that we have the best record of ancient architecture down to the beginning of our era, uncontaminated with any of the later debasements which so soon began to creep in, and it is in such work as Professor Weichhardt has given us that we may find the best interpretation of the remains which are left to us.

The Strength of Wire Rope.

A VERY exhaustive series of investigations into the resistance of wires and wire rope, both as regards tension loads, and bending action, has been made at the government testing-laboratory at Berlin, by Professor Rudeloff, and the results have been incorporated in a valuable double number of the *Mitt. aus den Kgl. technischen Versuchsanstalten* recently published (Parts III and IV, 1897).

The work contains a careful discussion of the subject, and the reputation of the author lends added value to the new data thus placed on record. A large portion of the paper consists of tabulated records of experiments, which must be consulted to be appreciated, but there are some portions of the report which can be reviewed in general terms, and which may serve to give an idea of the remainder.

The tests were intended to investigate the resistance both of single wires and of the same wires twisted into rope. For the tests of single wires a special machine of one-ton capacity was constructed by Prof. Rudeloff, while for the wire ropes the fine 50-ton testing machine of Prof. Martens was used. The tension loads were increased successively, and the extensions measured within 0.1 mm.; the test length being 300 mm. As the stretch ceased to be proportional to the increase of load, the elastic limit was noted, and the breaking load was then determined within a probable error of 2 kilograms for the single wires, and 5 kilograms for the wire ropes.

The device for measuring the resistance of the wires to repeated bending under various loads was a simple apparatus, the weight being suspended directly to the end of the wire, and the latter passing up between two cheeks, the ends of which were finished to the desired radius of curvature, the cheeks being rocked mechanically. The apparatus permitted six wires to be tested simultaneously, and the whole mechanism was constructed in the workshop of the laboratory for these especial tests. In this device tests were made showing the influence of changes in load upon the number of bendings before breakage occurred, the radius of curvature of the bend remaining constant. Tests also were made with constant loads and varying radii of curvature, and these two series are of especial value in connection with the use of wire for hoisting and power transmission.

The results of these tests are plotted, not only in the usual form of curves in plane co-ordinates, but also in solid models, showing as in three dimensions the relations of load, radius of curvature, and life in number of bends. For the detailed account of this portion of the work the original paper must be consulted but in general the following deductions were made:

The endurance of wires under repeated bending over a uniform radius of curvature diminishes rapidly with the increase of load up to loads of about 6,000 pounds per square inch, but for further increase of load the reduction in endurance proceeds more and more slowly.

The endurance under repeated bending from increasing loads, diminishes the more rapidly the less the resistance and the greater the extensibility of the material.

The influence of increasing radius of bending upon the endurance was rapid at first, but showed a continually-diminishing importance above 50 diameters of the wire.

These tests, as well as the tests of wire ropes, were made upon wires of various strengths, in order to obtain a progressive series of points through which curves could be drawn.

The tests with the ropes were made upon the materials used for the single wires, so that a series of relations between a given wire and a rope made from the same wire were established. In some instances the strength of a rope per unit of cross-section was greater than that of the single wires of which it was composed, but in others it was much less, depending upon the material and the conditions of test.

This important work was undertaken especially to furnish data for the use of wire rope in connection with the mining industry of Germany, but will doubtless be welcomed by users and makers of wire and wire rope in all countries.

A New Railway Station in Paris.

THE Quai d'Orsay will be remembered by all the visitors to the Paris Exposition of 1889 as a sort of connecting link between the main buildings on the Champ de Mars and those on the Esplanade des Invalides, and on this portion of the river front a number of important and interesting exhibits were then placed. It is now proposed to bring the line of the Orleans railway into the city by means of a subway as far as the Quai d'Orsay, and there to build a new passenger station which shall not only greatly increase the capacity for handling traffic, but also be an ornament to what is already one of the most beautiful portions of Paris.

Accounts of this important engineering and architectural work appear in several of the technical journals, and from *Le Génie Civil* (December 11, 1897) and *La Revue Technique* (November 25, 1897) we make extracts.

At the present time the Orleans railway enters Paris as far as the Pont d'Austerlitz, a short distance above the island of the Cité, and a large station, the *gare d'Austerlitz-Orleans*, is situated there, on the left bank of the Seine. It is now proposed to carry the line of the railway on the left bank through a subway as far as the Quai d'Orsay, and on the site of the former palace of the *Cour des Comptes*, the blackened ruins of which have remained since 1870 to mark the doings of the Commune, a new station is to be erected.

There has been much discussion in Paris as to the possibility of designing a railway station which shall not injure by comparison the fine architectural structures which, both historically and artistically, add so much to this locality. In order to obtain the best results, a schematic plan has been prepared by the railway company, including all the essential points so far as the operation of the work of the station is concerned, and three comparative designs have been made by as many well-known architects for the details and façade. The designs have been submitted to a commission of experts, and the plans are now published with sketch elevations in the *Génie Civil*.

The general appearance of the various designs is affected mainly by the fact that the architects were commissioned to prepare plans respectively for a station without a hotel, a station with a hotel as a secondary attachment, and a station with a grand hotel. While the addition of a hotel to the buildings of the terminal proper gives the architect increased opportunity for decorative treatment, yet, in the opinion of M. Laloux, one of the architects, it is not a matter of real importance, since in this location there is small probability of the building being used for anything but minor transient accommodations, surrounded as the station will be by the great hotels of Paris.

The plans all show the offices, waiting-rooms, and other buildings placed by the side of the train shed,—not arranged in the form of a "head house," as is sometimes the case,—and as the tracks are below the surface, passengers will thus be enabled to descend between any lines of rails without crossing the tracks. The train shed will be about 130 feet span, with six tracks under this width, and six more under the remainder of the structure, providing both for through and local traffic in a very convenient manner. Judging from the appearance of the proposed plans, any of them would be considered ornamental in other locations, and even on the proposed site will not, in our opinion, detract from the dignity of the surroundings.

The subway by means of which the tracks are to be conducted from the *gare d'Austerlitz* will be a difficult piece of construction for several reasons. Passing as it will under the quay along the bank of the Seine, its tunnel will cut through the shore abutments of a number of the finest bridges of Paris, but every precaution has been taken in the design to provide for the reinforcement of the masonry at the necessary points, the cross-section of the tunnel being made elliptical with a complete masonry ring to resist horizontal pressure to the best advantage. Between the bridge piers the subway is planned to be partially open on the side toward the river, the quay pavement above being supported by posts and girders, and heavy retaining walls sustaining the lateral pressure on both sides.

Much solicitude has been expressed as to the fate of the numerous trees with which the river front is lined, and a special report has been made upon this subject. According to this investigation it will be possible to save a large number of the trees, and, as many of those to be sacrificed are claimed to be not worth saving, the beauty of the city will suffer but little in this respect.

The completion of this important work will give Paris what has long been needed,—rapid subway transit to the heart of the city, as well as increased main line accommodation,—and, in addition, will do much to assist in providing for the flood of travel expected in the exposition year.

Antique Copper Tools.

ANTIQUARIAN researches are not always of technical interest, but, when a scientist of the reputation of M. Berthelot takes the trouble to investigate the composition and physical properties of metallic tools which are of authentic antiquity, it may be worth while to examine with him the materials with which the ancient Egyptians and their contemporaries did their work and killed each other. M. Berthelot has contributed a very interesting article upon this subject to the *Annales de Chimie et de Physique*, from which we make extracts.

The ages of the specimens examined by M. Berthelot were in some cases established by inscriptions on the articles themselves; this being the case especially with the case of the sceptre of Pépi I, of Egypt, and of the lance of the king of Kish, at Tello. In other instances the dates were determined approximately from the character of other articles contained in the tombs in which they were found; care being taken not to confound genuine antiques with tools left by later hands, such as are often found in cases where mediæval violators and treasure-seekers have rifled the ancient burial-places. While some of the articles were undoubtedly intended solely for ornament, and some for military weapons, others were evidently designed for tools, and, as such, possess an interest to engineers, both from their form and from their composition. Among these one of the most interesting is a small chisel, found in the necropolis of Toukh, in Egypt. This tool is now about 80 mm. long, but was originally somewhat longer, the upper portion showing a broken end. The body is 4 mm. wide by 2 mm. thick, and the lower end is flattened out into a cutting edge of about 6 mm. in width, by scarcely ½ mm. in thickness. Although much oxidised and covered with verdigris, the composition of this little tool is shown by M. Berthelot to consist entirely of pure copper, without a trace of tin. Similar results were obtained by analysis of a number of other articles, including needles, spears, a hatchet, etc., and there is every reason to believe that these tools and weapons were composed, not of a bronze or other alloy, but of pure copper, corresponding in all respects to the metal we are familiar with to-day.

Because of the oxidised and crumbling condition in which these tools are found to-day, no conclusions can be drawn as to their original temper or hardness, but, unless they were so hardened as to retain their cutting edges, it is difficult to see how they could have served the purposes for which they evidently were designed. These examples, however, show at least that any temper which the ancient tools possessed was not due to any especial alloy or composition of various metals, and that, if any hardening process was known to the ancient Egyptians it must have been one which was applied to the pure copper itself.

Slag as a Material of Construction.

VARIOUS attempts have been made to utilize blast-furnace slag as a material of construction, but usually without permanent success. The hygroscopic nature of the material renders it perishable and crumbling when exposed to the action of the atmosphere, thus rendering it unsuitable for paving, while the glassy impermeability unfits it for many uses to which bricks are now applied. Of late certain slags have been found suitable for the manufacture of cement, and we have already noticed this method of using slag in the arts. A similar application is found in the production of artificial stone, and the objectionable features of the primitive article seem to have been overcome by the use of the granulated slag, cemented into a mass in one or the other of several ways and moulded into any required form by pressure.

An article by Herr Lürmann, in *Stahl und Eisen* (December 1, 1897) gives a very full account of the extensive manufacture and use of this material in Germany, together with a set of plans for buildings and machinery suitable for the production of bricks of slag.

The granulation of the slag is effected by discharging it, in the molten condition, as it flows from the furnace, into a tank of water, in a manner similar to that used in the preparation of slag cement. The water in the tank becomes opalescent by solution of a portion of siliceous acid, and this soluble siliceous acid, after a short time, binds the whole mass together, especially if pressure be applied. This cementing is more effectively accomplished if a portion of finely-ground slag be used in connection with the coarser granulated material, although a somewhat longer time is required for the mass to become hard. The time required for hardening may be reduced to six or eight days, if about ten per cent. of slaked lime be mixed with the slag, the combined action of cement and mortar thus being effected.

This method of utilizing slag is by no means new, having been used by Langen as long ago as 1862; and an official report of that date states that test specimens made with one part of lime to five parts of granulated slag showed nearly 60 per cent. of the compressive resistance possessed by neat Portland cement.

At first the material was compressed into bricks by use of a simple form of hand press, constructed on the toggle-joint principle; three men turning out about one thousand bricks per day of ten hours. This method, however, was defective, owing to the insufficient degree of pressure attained, and the product was unsatisfactory, being too porous and fragile.

The introduction of power presses has entirely remedied this difficulty, and at the present time brick-making plants, using slag as material, are adjuncts to many of the German blast furnaces.

The bricks, as usually made, are in the standard German proportions of 250 × 120 × 65 millimeters, resembling a light sandstone in appearance, and have clean, smooth surfaces and sharp angles. They are best laid with very thin mortar joints, and their use shows a noteworthy economy of mortar, for this reason. The strength of these bricks is not greatly different from those of ordinary burned clay. A safe working-load may be taken at about 200 pounds per square inch, the crushing strength being about 1,500 pounds per square inch. The resistance to the action of heat is excellent, and they are satisfactorily used for chimney and flue construction.

The plant described in Herr Lürmann's paper is intended for a capacity of 8,000 bricks per day, and involves an original outlay of 40,000 marks (£2,000 or $10,000), and the estimated cost of operation, including interest and depreciation, brings the cost of the bricks to about 12 marks (12 shillings or $3.00) per thousand.

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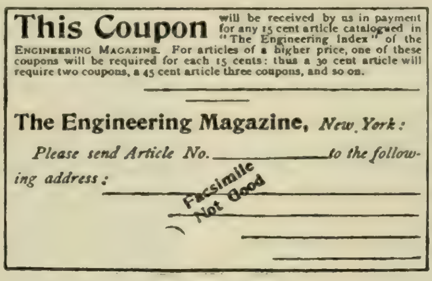

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Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m.* New York.
Chautauquan. *m.* Meadville, Pa
Chem. Met. Soc. of S. Africa. *m.* Johannesburg, S. A. R.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.

Elektrotechniker. *b-m.* Vienna
Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Engineer. *w.* London.
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Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal
Mining Industry and Review. *w.* Denver, Col.
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Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. Stuttgart.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Science Review. *qr.* New York.
New Zealand Mines Record. *m.* Wellington, N. Z.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *q.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway & Engineering Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revue Technique. *b-m.* Paris.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerisches Bauzeitung. *w.* Zurich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Scientific Machinist. *s-m.* Cleveland, Ohio.
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J
Stone. *m.* Chicago, Ill
Street Railway Journal. *m.* New York
Street Railway Review. *m.* Chicago, Ill
Technology Quarterly. Boston, Mass.
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill.
Western Railway Club, Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Zeitschrift für Lokomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.
Zeitschrift für Instrumentenkunde. *m.* Berlin.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Bath Buildings.

The Wentworth Avenue Free Baths, Chicago. Description and plans of the largest public bath house yet established in this country, having a capacity of nearly 100 baths an hour. 1700 w. Eng Rec—Dec. 11, 1897. No. 17116.

Building Construction.

Building Construction in Relation to the Public Health. Peter Fyfe. Principally confined to the work of the carpenter and joiner, discussing how the leading principles of sanitation should be applied. Also editorial. 7000 w. San Rec—Dec. 10, 1897. No. 17191 A.

Cement Plaster.

The Technology of Cement Plaster. Paul Wilkinson. Gives the history of the discovery of the product bearing this name, and explains the process of preparing the material for use. 3700 w. Trans Am Inst of Min Engs—Nov., 1897. No. 16954 D.

Competition.

Prize Designs for Business and Apartment Buildings in Vienna. (Die Preisausscheibung für den Umbau des Hauses, I. Kärntnerstrasse Nr. 24, in Wien.) Examples of modern Viennese architecture, with plans and elevations. 1200 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 3, 1897. No. 17341 B.

Construction.

Important Problems in Construction. William W. Crehore. Considers wooden construction and load distribution. Ill. 1600 w. Br Build—Dec., 1897. No. 17292 C.

Eiffel Tower.

The Stability of the Eiffel Tower. (Sur la Stabilité de la Tour Eiffel.) A report upon the movements of the tower, due to the action of the wind, of solar heat etc. A daily period was found, but no appreciable displacement of the apex during the year 1896-97. 1000 w. Comptes Rendus—Dec. 6, 1897. No. 17323 D.

Exposition.

The Exposition of 1900. (Exposition de 1900.) A review of the present condition of the work on the Champs-Elysées and the Champ-de-Mars. 2000 w. Le Génie Moderne—Nov. 15, 1897. No. 17313 B.

The Paris Exhibition of 1900. An account of preparations being made by the removal of buildings and the contracting for the new structures. 2000 w. Engng—Dec. 3, 1897. No. 17117 A.

The Prize Design for the Vienna Pavilion. (Die Preisausschreibung für den Pavillon der Stadt Wien.) With illustrations of the first, second. and third prize designs for the city pavilion for the jubilee exposition to be held at Vienna in 1898. 1500 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 12, 1897. No. 17338 B.

The Sites of the Exposition of 1900. (Les Emplacements de l'Exposition de 1900.) An historical account of the portions of Paris which are to be used for the exposition, with plans at various periods from 1609. An interesting account of a part of old Paris. Serial. Part I. Le Génie Moderne—Nov. 15, 1897. No. 17314 B.

Fire Dangers.

Warehouse and Factory Fire Dangers. George H. Bibby. Discusses the construction of these buildings and the causes of the spread of fires within the buildings. 2000 w. Arch, Lond—Dec. 3, 1897. No. 17131 A.

Foundations.

Some Details of Pneumatic Foundation Work. Illustrated description of the foundations of the Empire Building, corner of Rector street and Broadway, New York. 1300 w. Eng Rec—Dec. 11, 1897. No. 17111.

Library.

New York's New Public Library. Edwin Emerson, Jr. Illustrations of the outside of the building with some remarks on special features of the accepted design. 1200 w. Harper's Wk—Dec. 11, 1897. No. 17062.

The New York Public Library. Description with illustrations and general information. 1600 w. Eng Rec—Dec. 11, 1897. No. 17115.

McEwan Hall.

McEwan Hall, Edinburgh University. R. A. Illustrations, plan and general description of a beautiful building recently opened. 1500 w. Builder—Dec. 11, 1897. No. 17224 A.

Municipal Buildings.

The New Municipal Buildings, Toronto. A résumé of the plans and specifications as finally adopted for the heating, plumbing, ventilation, gas and electric wiring. 2800 w. Can Arch—Dec., 1897. No. 17440 C.

Pompeii.

Pompeii before the Destruction. (Pompeji vor der Zerstörung.) A review of Weichhardt's recent work, with a number of reproductions of his restorations of the temples and other buildings. A valuable contribution to architecture and archæology. Four articles, three plates. 5000 w. Schweizerische Bauzeitung—Nov. 20, 27, Dec. 4, 11, 1897. No. 17367 H.

Schools.

The Planning of High and Endowed Schools for Girls. F. J. Osborne Smith. Read at meeting of the Architectural Association, London. Considers the types of plans which experience has proved to be best suited for the work. Also the fittings for cloak-rooms, lavatories, &c. 5500 w. Arch, Lond—Dec. 10, 1897. No. 17209 A.

The Roman Catholic Protectory of Philadelphia, Pa. Illustration of the building and the mechanical plant for heating and ventilating. 2500 w. Eng Rec—Dec. 18, 1897. No. 17189.

Stone-Cutting.

Practical Stone-Cutting. Charles H. Fox. Part first is introductory to a description of methods claiming to be superior to those usually employed. 3800 w. Stone—Dec., 1897. Serial. 1st part. No. 17286 C.

HEATING AND VENTILATION.

Conservatory.

The Warming and Ventilating of the Horticultural Buildings at the Hamburg Exposition. (Heiz und Luftwesen auf der Gartenbauausstellung in Hamburg.) With full details of the hot water system of these important buildings especially intended as a model plant. 3500 w. Zeitscher d Ver Deutscher Ing—Nov. 27, 1897. No. 17333 D

Heating Installations.

Installation of Successful Heating Systems. Reviews the information necessary to decide upon the best system; discusses various systems and matters relating to their installation. 2000 w. Dom Engng—Dec., 1897. No. 17271 C.

House Heating.

European Systems of House Heating. J. L. Saunders. Comparing British and American methods, and noting differences due to climatic conditions. The British house-heating practice is growing more and more like American. 2500 w. Engineering Magazine—Jan., 1898. No. 17399 B.

Humidity.

The Humidity of the Air. (Der Feuchtigkeitsgehalt der Luft.) Bruno Griep. Discusses the question in connection with house heating, and maintains that for health the humidity should be maintained the same as exists with the corresponding temperature in summer. 2000 w. Gesundheits Ingenieur. Nov. 15, 1897. No. 17361 B.

School Houses.

Automatic Heat Control in School-House Ventilation. Illustrated description of an interesting arrangement used in the school building, corner of Carson and Tenth streets, in Pittsburg, Pa. 3000 w. Eng Rec—Dec. 4, 1897. No. 17041.

Ventilating System.

A Ventilating System in Connection with a Furnace. Detailed description of a system in operation during last winter in the residence of J. P. Watson, Flatbush, N. Y., used in connection with a Thatcher furnace. 2000 w. Met Work—Dec. 18, 1897. No. 17181.

LANDSCAPE GARDENING.

Park Protection.

Landscape Gardening. Editorial on the aims of this art, and on the dangers threatening the parks of New York. 2000 w. Gar & For—Dec. 22, 1897. No. 17246.

Parks.

Park-Making. Editorial suggestions and criticisms. 1000 w. Gar & For—Dec. 15, 1897. No. 17157.

Villa Lante.

The Garden of Villa Lante. Harold Van Buren Magonigle. Illustrated description of this lovely formal garden of Italy. 1300 w. Am Arch—Dec. 25, 1897. No. 17291.

PLUMBING AND GASFITTING.

Drain Ventilation.

The Sanitary Arrangements of the Public Offices at Dauba, Bohemia. (Ueber die Einrichtung der Abortanlage in dem Amtsgebäude zu Dauba.) The ventilating pipes from the closets are connected to a flue in the chimney, thus causing a constant and powerful ventilation. 2000 w. Oesterr Monatschr f d Oeffent Baudienst—Dec., 1897. No. 17359 D.

Inspection.

Duties of a Plumbing Inspector. Henry Sieben. Discusses the duties and gives the Kansas City methods. 1200 w. Dom Engng—Dec., 1897. No. 17267 C.

Regulations.

Plumbing Regulations and Their Practical Application. W. F. Taaffe. A résumé of the code of the New York Building Department, with explanations. 1800 w. San Plumb—Dec. 15, 1897. Serial. 1st part. No. 17197.

The Regulation of Plumbers' Work. Thomas S. Ainge. Remarks on this subject suggested by a bill presented to the Legislature of the State of Michigan. States briefly the existing laws, giving reasons why they are necessary. 2800 w. Dom Engng—Dec., 1897. No. 17269 C.

MISCELLANY.

Address.

Presidential Address before the Society of Architects, London. T. Walter L. Emden. Considers the profession, sanitation, art, and the drawbacks to the profession. 3800 w. Arch, Lond—Dec. 3, 1897. No. 17132 A.

Fireproofing.

A Competitive Test of a Hollow Tile and a Concrete Fireproof Floor. Describes an arranged test growing out of a challenge by Henry Maurer & Sons, of New York, manufacturers of hollow tile fireproofing, and responded to by the firm of John A. Roebling's Sons Co. Ill. 1500 w. Eng News—Dec. 2, 1897. No. 16992.

Fire Protection.

Protection Against Fire in Museums. Report on English museums as discussed by the Select Committee on Museums, of the Science and Art Department. 5700 w. Arch, Lond—Nov. 26, 1897. No. 16996 A.

History.

The History of Architecture. Prof. Aitchison. Abstracts of four lectures on this subject, delivered in the Alexandra College, Dublin. 3500 w. Arch, Lond—Dec. 3, 1897. No. 17133 A.

Malta.

Notes on Renaissance Architecture in Malta, with Special Reference to the Buildings of the Order of St. John. Arthur S. Flower. A very interesting paper, giving an account of the beautiful architecture of the island, and much information. Discussion. Ill. 12000 w. Jour of Roy Inst of Brit Archs—Nov. 20, 1897. No. 17215 D.

Medieval Architecture.

Norman Gothic or Medieval Architecture. Cyrus K. Porter. A general outline of the subject confined to a study of its development in Great Britain. 6800 w. Stone—Dec., 1897. No. 17287 C.

Mural Painting.

Frank D. Millet's Mural Painting for Pittsburg. Charles H. Caffin. An interesting description of the painting for the main hall of the Bank of Agriculture. Ill. 1000 w. Harper's Wk—Dec. 25, 1897. No. 17243.

Tenements.

Improved Tenement Homes for American Cities. Gustavus A. Weber. Considers the needs of this class, discussing the conditions in various cities, and giving suggestions for general application. 6500 w. Munic Affairs—Dec., 1897. No. 17450 C.

Newcastle, Eng.

A Review of Newcastle Architecture. Frank W. Rich. A short but interesting review of the progress of architecture during the present reign, taken from the inaugural address before the Northern Architectural Assn. 2200 w. Builder—Nov. 20, 1897. No. 16927 A.

U. S. Capitol.

The United States Capitol Building, and the Architects of the Capitol. Historical account of the building, with views and features of special interest, and biographical accounts of the architects connected with the work. 3800 w. Arch & Build—Dec. 4, 1897. No. 17030.

Woodwork.

The Treatment and Decoration of Woodwork. Walter J. Pearce. Many suggestions, and criticisms of prevailing practice. Ill. 2500 w. Plumb & Dec—Dec. 1, 1897. No. 17153 A.

CIVIL ENGINEERING.

BRIDGES.

Arch.

Influence Lines for Rigid Framed Arches. (Einflusslinien des Gelenklosen Bogens.) A graphical discussion of the rigid braced arch, showing the positions of the possible lines of pressure. Three articles. 5000 w. Schweizerische Bauzeitung—Nov. 6, 13, 27, 1897. No. 17366 E.

Channel.

A New Scheme for Crossing the Channel. (Un Nouveau Mode de Traversée du Pas de Calais.) The plan involves the construction of a submarine railway bridge similar to that used at St. Malo, carrying rolling "ferry-boats," with chain haulage. 2500 w. Le Génie Moderne—Dec. 1, 1897. No. 17315 B.

Chicago Canal.

Proposed Bridges Across the Chicago Drainage Channel. Extracts from the specifications, with drawings and general information. 4200 w. R R Gaz—Dec. 3, 1897. No. 16967.

Cornhouse Bridge.

The Cornhouse Bridge at Berne, Switzerland. Elmer L. Corthell. The article is supplemental to one published in this paper in issue of Dec. 19, 1895, giving illustrated description of special features of this bridge now nearing completion. 2000 w. Eng News—Dec. 16, 1897. No. 17176.

Drawbridges.

Railway Drawbridges Over the Chicago Drainage Canal. Describes four of the five railway bridges crossing this channel, giving specifications and illustrations. 5000 w. Eng News—Dec. 2, 1897. No. 16991.

Floating Bridge.

Carriage and Passenger Floating Bridge. Illustrated description of a bridge built for the Southampton and Itchen Floating Bridge and Roads Company, which has proved an advance in general efficiency and economy. 1100 w. Engng—Nov. 26, 1897. No. 17008 A.

Lifting Bridge.

Lifting Bridge Over the Murray River at Swan Hill. This river is the natural boundary between New South Wales and Victoria, and bridges over it are erected at the joint expense of the two colonies. Illustrated detailed description. 1000 w. Engr, Lond—Nov. 19, 1897. No. 16918 A.

Loads.

Suddenly Imposed Loads. Editorial discussion of what constitutes a suddenly imposed load, and the action of live loads. 1600 w. Engr, Lond—Nov. 26, 1897. No. 17020 A.

North River.

Bridging the North River. Walter H. Knight. A letter to the editor explaining why the writer considers a tunnel under the North River at New York the much more feasible plan. 1000 w. R R Gaz—Dec. 10, 1897. No. 17090.

Paint Tests.

Paint Tests. Discussion by W. J. Wilgus of paper by Max Toltz, with the practice favored by the writer. 1000 w. Jour Assn Engng Socs—Nov., 1897. No. 17285 C.

Swing Bridge.

Lifting a Chicago Swing Bridge. Explains how the repairs of the Randolph street bridge, in Chicago, were carried out. 600 w. Eng Rec—Dec. 11, 1897. No. 17112.

Double-Track Electric-Railway Viaduct for St. Louis and Suburban Ry. at Edgebrook, Mo. Illustrates and describes a steel structure recently erected about eight miles from St. Louis, Mo. 1200 w. Eng News—Dec. 23, 1897. No. 17255.

Viaduct.

The Müngsten Viaduct. (Die Thalbrücke bei Müngsten.) A fully illustrated account of this fine viaduct at Müngsten, near Düsseldorf; the great arch is 525 feet span, and the total length 1640 feet. Three articles. Four plates. 12000 w. Zeitschr d Ver Deutscher Ing—Nov. 20 Dec. 4, 11, 1897. No. 17329 H.

CANALS, RIVERS AND HARBORS.

Baltic Canal.

The Influence of the Kaiser-Wilhelm Canal upon the Port of Hamburg. (Die Einwirkung des Kaiser Wilhelm Canals auf die Seeschiffahrtsstellung Hamburgs.) Showing that Hamburg has been benefitted rather than injured by the opening of the canal between the North Sea and the Baltic. 2500 w. Oesterr Monatschr f d Oeffent Baudienst—Dec., 1897. No. 17358 D.

Bulkhead.

The New Delaware River Bulkhead at Philadelphia, Pa. Describes the method of work contemplated, giving illustrations. 900 w. Eng News—Dec. 9, 1897. No. 17070.

Coast Improvement.

The Control and Fixation of Shifting Sands. John Gifford. Proper forestry cultivation will convert shifting sands into fixed soil and enable large areas to be reclaimed. Many valuable and interesting instances are given. 4000 w. Engineering Magazine—Jan., 1898. No. 17396 B.

Chicago Canal.

The Status of Work on the Chicago Drainage Canal. Abstract of message of the new president, William Boldenwick, reviewing progress of the work and outlining works yet to be executed. 2000 w. Eng News—Dec. 23, 1897. No. 17254.

Danube.

The Regulation of the Rivers of Hungary. (Ueber die Flussregulierungen in Ungarn.) Discussing principally the improvements in the middle Danube between Duna-Radvány and Báziás. 5000 w. 1 map. Oesterr Monatschr f d Oeffent Baudienst—Dec., 1897. No. 17357 D.

Docks.

Extension of the Liverpool Docks. Information of the extensions and improvements now in progress and in contemplation, with description of the docks, port and harbor. 3300 w. Cons Repts—Jan., 1898. No. 17281 D.

Repairing the Leak at Dry Dock No. 3, Brooklyn Navy Yard. Illustrated description of this difficult piece of engineering work now in progress. 1700 w. Sci Am—Dec. 25, 1897. No. 17261.

The New Concrete and Steel Government Docks at Puerto Cabello, Venezuela. Brief illustrated description of a rather novel construction. 700 w. Eng News—Dec. 23, 1897. No. 17257.

Drainage.

The Drainage of Lake Fucino. (Die Trockenlegung des Fuciner Sees.) An account of the completion of the recovery of 35,000 acres by the drainage of Lake Fucino, in Italy, by Prince Torlonia. The total cost of the work was $3,300,000. Two articles, 5000 w. Deutsche Bauzeitung—Nov. 27, Dec. 4, 1897. No. 17890 E.

Gaging.

A Study of Gaging Statistics. (Etude sur la Statistique des Jaugeages.) M. Bresse. Giving a very full résumé of the measurements of flow of the principal rivers of France under various conditions, considered in connection with the basins which they drain. 20,000 w, 5 plates. Ann des Ponts et Chaussées, Part III. 1897. No. 17344 F + G.

Lighthouses.

Lighthouses and Light-Vessels. Discussion of the fifth and final report of the Royal Commission on Electrical Communication with lighthouses. 2500 w. Elec Rev, Lond—Dec. 5, 1897. Serial. 1st part. No. 17120 A.

Marseilles.

Enlargement of the Port of Marseilles. (Agrandissement du Port de Marseille.) With plan of the present condition of the harbor, and an account of the proposed docks, with section of the new breakwater. 1200 w. Le Génie Civil—Nov. 20, 1897. No. 17304 D.

Enlargement of the Port of Marseilles, France. From *La Nature*. Explains the reasons that prompted the work, and the conditions under which it is being executed. Ill. 1600 w. Sci Am Sup—Dec. 25, 1897. No. 17266.

Nicaragua Canal.

The Dream of Navigators. A. S. Crowninshield. Showing the value and importance of the Nicaragua Canal and urging its construction under the auspices of the United States Government. 2800 w. N Am Rev—Dec., 1897. No. 16949 D.

Pile-Driving.

Pile-Drivers and Pile-Driving. Perry F. Nursey. A consideration of this subject showing why a heavy ram with a short fall does the most efficient work. 2000 w. Ind & Ir—Dec. 17, 1897. No. 17454 A.

Plymouth, Eng.

Harbor Extension at Plymouth. Recommendations from the report of J. Wolfe Barry and Cuthbert Brereton to the Corporation of Plymouth, in reply to the points submitted for their consideration relative to the advisability of making this extension. 1300 w. Transport—Nov. 26, 1897. No. 17005 A.

Ship Canals.

Some Early Ship Canals. A review of the various schemes projected in England. 1100 w. Engr, Lond—Nov. 26, 1897. No. 17019 A.

The Lake Erie and Ohio River Ship Canal. Information from the report of the provisional committee of the Pittsburg Chamber of Commerce. Gives argument for the building of this canal, route proposed, summary of estimates of cost, &c. 1200 w. Eng News—Dec. 23, 1897. No. 17256.

The Race to the Atlantic Seaboard between Canada and the United States. Editorial discussion of the projects being considered to connect the Great Lakes with the sea. 2000 w. Transport—Nov. 19, 1897. No. 16934 A.

Surveying.

Hydrographic Surveying—How the Maps and Charts of our Coast and Harbors are Made. Thomas C. Harris. A brief explanation of the work done in American waterways, by the government engineers, to insure safe passage through harbors. Ill. 2000 w. Sci Am—Jan. 1, 1898. No. 17463.

Towing.

See Electrical Engineering. Power.

IRRIGATION.

Corona, California.

Pipe Line No. 2 and the Lands Irrigated under it at Corona, Riverside Co., Cal. H. Clay Kellogg. Gives the source of the supply, materials used, the engineering work, &c. 3000 w. Jour Assn of Engng Socs—Nov., 1897. No. 17284 C.

Cyprus.

Irrigation Works in Cyprus. Discussion of the work about to be undertaken to store up the supply of water for irrigation of the plains during the dry season. 1200 w. Engr, Lond—Nov. 26, 1897. No. 17018 A.

Drainage.

Dimensions of Channels for Surface Drainage. Charles Edward Livesey. From Proceedings of Institution of Civil Engineers, (England) Vol. CXXVIII. Statement of theory and description of its application in the construction of irrigation works in India. 2800 w. Jour W Soc of Engs—Oct., 1897. No. 17088 D.

India.

Indian Droughts and Irrigation. Reviews the improvements that have been made in India, the present conditions, and remedies needed. 2000 w. Nov. 15, 1897. No. 16929 A.

Madras, India.

Schemes for Extending Irrigation. W. Hughes. Note presenting a few schemes likely to be of use in preventing famine. 700 w. Ind Engng—Nov. 6, 1897. No. 17066 D.

Madura, India.

The Diversion of the Periyar. John Pennycuick. Abstract from Proceedings of the Institution of Civil Engineers (England) Vol.. CXXVIII. An account of work in India for the irrigation of the Madura district. 1700 w. Jour W Soc of Engs—Oct., 1897. No. 17087 D.

MISCELLANY.

Artificial Stone.

The Manufacture of Building Stone from Granulated Slag. (Mauersteine aus Granulirten Schlacken.) Describing a plant for making artificial stone from blast furnace slag. The granulated slag is mixed with lime mortar and compressed into blocks. A number of such plants are in successful operation in Germany. 4500 w. 1 plate. Stahl und Eisen—Dec. 1, 1897. No. 17350 D.

Cement.

Cement Tests in the Year 1896-1897. (Cementuntersuchungen aus dem Betriebsjahre 1896-1897.) Official report of the tests made in the Royal Testing Laboratory at Berlin, with many tables of data and results of the work of the past fiscal year. 15000 w. Mittaus d Kgl Tech Versuchsanstalt—Part V. 1897. No. 17377 F.

New Portland Cement Plant of the Coplay Cement Company. Frederick H. Lewis. An illustrated description of a plant producing 500 bbls. daily. The latest types of kilns and mills are used, and both processes and machinery are explained. 3000 w. Eng Rec—Dec. 18, 1897. No. 17184.

The Portland Cement works at Volsk, on the Volga. (Die Portlandzementfabrik Wolsk a. d. Wolga.) With plans, sections and elevation of the large buildings, and an account of the plant. The output is 300,000 barrels, of 375 pounds each, per year. 1500 w. Zeitschr d Ver Deutscher Ing—Nov. 27, 1897. No. 17332 D

Concrete.

Computations for Floors and Beams in Reinforced Cement. (Du Calcul des Planchers et Poutres en Ciment Armé.) A valuable article by M. Louis Stellet, upon the methods of proportioning constructive details of combined iron and concrete, including the researches of Hennebique, Cottancin, and others. 6000 w. La Revue Technique—Dec. 17, 1897. No. 17312 D.

Earthwork.

A Contribution to the Computation of Earthwork. (Ein Beitrag zur Erdmassenberechnung.) Giving a simplified approximate method especially adapted for cutting and filling, based upon the summation of a series of rectangular sections. 1200 w. Oesterr Monatschr f d Oeffent Baudienst—Dec., 1897. No. 17360 D.

Roads.

First Report of Committee on Roads. A list of specimens of stone pavements imported and exhibited at the Pittsburg Exposition, with discussion of these and other systems. Ill. 6500 w. Pro Engs' Soc of W Penna—Sept., 1897. No. 17441 F.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

American Commerce.

The Trend of American Commerce. Cyrus C. Adams. Reviews the influences that are stimulating American commerce, and shows that energetic movements are being made to embrace opportunities for trade. 3300 w. Chau —Dec., 1897. No. 16993 C.

British India.

The Foreign Trade of British India. Account taken from the report of J. E. O'Connor, Director-General of Statistics to the Government of India. 900 w. Bd of Trd Jour—Nov., 1897. No. 16903 A.

China.

American Trade in China. J. T. M. Reports an interview with T. R. Jernigan, ex-consul general of the United States to Shanghai, discussing the railway contract situation and the field for American supplies. Also editorial. 2500 w. Ry Age—Dec. 3, 1897. No. 17042.

The Opening Up of Southwestern China. Report of the opening of the territory of the West River to foreign trade. 3200 w. Bd of Trd Jour—Nov., 1897. No. 16902 A.

Competition.

Future Supremacy in the Iron Markets of the World. J. Stephen Jeans. Compares the relative advantages of various countries in point of crude materials, and shows the strength of England's position in this respect. 4500 w. Engineering Magazine—Jan., 1898. No. 17394 B.

Russian Competition with Indian Trade. An explanation of the conditions and the class of goods most affected, with suggestions of steps necessary to maintain British trade. 1300 w. Bd of Trd Jour—Dec., 1897. No. 17465 A.

Currency Plan.

The Secretary of the Treasury's Currency Plan. Statement of the recommendations of Mr. Lyman J. Gage, Secretary of the United States Treasury. 1700 w. Eng & Min Jour—Dec. 11, 1897. No. 17103.

Discriminating Duties.

Discriminating Duties in the United States. Letter from the Attorney-General to the Secretary of the Treasury of the United States. 3500 w. Bd of Trd Jour—Dec., 1897. No. 17-467 A.

English Colonies.

The Colonies: Their Arts, Manufactures and Commerce. Owen Tudor Burne. Gives general facts and figures relating to the condition of the colonies, and shows that their commerce holds a good position in the world. 6500 w. Jour Soc of Arts—Nov. 19, 1897. No. 16905 A.

Foreign Markets.

Another Lesson from Germany. Editorial on the account given by British Consul Powell to Lord Salisbury, of the Association for the promotion of foreign commercial relations with Stettin, showing its aims and objects. 1200 w. Engng—Dec. 17, 1897. No. 17418 A.

How to Win the Foreign Market. Henry C. Carpenter. A letter to the Department of State giving a few hints to American manufacturers who want business and are willing to work for it. 1600 w. Cons Repts (U. S. A.)—Dec., 1897. No. 17204 D.

German Association for the Promotion of Foreign Trade. An account of means taken to extend and improve the trade of Stettin. Consular report giving information to the Foreign Office of British Empire. 1700 w. Bd of Trd Jour—Dec., 1897. No. 17464 A.

Our Foreign Trade Methods at Fault. An explanation of the conditions to be met with and the methods now in use for extending American trade; also suggestions of necessary steps to be taken if much business is secured. 3800 w. Cons Repts (U. S. A.)—Dec., 1897. No. 17205 D.

Japan.

Trade Organization in Japan. An account of customs in trade, showing that guilds are common and trade associations numerous. 1400 w. Dom Engng—Dec., 1897. No. 17270 C.

Tariff.

Import Duties on Spirits and Wine in British Colonies and Possessions. Table showing the rates levied on spirits and wine imported into India, Ceylon, Canada, the Australasian Colonies, Natal, and the Cape of Good Hope. 2000 w. Bd of Trd Jour—Dec., 1897. No. 17466 A.

Influence of the Dingley Tariff on German Industries. Salient points of a memorandum drawn up by the Commercial Attaché of H. M. Embassy in Berlin, which gives a précis of a series of articles by experts on the subject in question. 3000 w. Bd of Trd Jour—Nov., 1897. No. 16901 A.

New Tariff of Cuba. A translation of the customs tariff for the island of Cuba, promulgated by the Spanish Government and printed in the *Gaceta de Habana* of September 9, 1897. 18000 w. Cons Repts (U. S. A.)—Dec., 1897. No. 17206 D.

Tariff Changes and Customs Regulations. Belgium, Netherlands, Germany, Italy, Switzerland, United States, Ecuador, Peru, Chile, Canada and Natal. 3300 w. Bd of Trd Jour—Nov., 1897. No. 16904 A.

Tariff Changes and Customs Regulations. Russia, Germany, France, Portugal, Spain, United States, Venezuela, Cape Colony, Victoria. 3500 w. Bd of Trd Jour—Dec., 1897. No. 17468 A.

CURRENCY AND FINANCE.

American Currency.

American Banking and Currency Schemes. W. R. Lawson. Considers the various phases of the subject, and the schemes advanced. 7000 w. Bankers' Mag, Lond—Dec., 1897. No. 17138 D.

Gold Sources.

The World's Quest for Gold. G. J. S. Historical review of the gold supplies, with comparison of the production of the past and present. 1600 w. Bankers' Mag, Lond—Dec., 1897. No. 17139 D.

Monetary Commission.

Monetary Commission Questions. A series of questions, formulated by the Monetary Commission appointed by the Indianapolis convention to investigate the banking and currency question and report a bill on the subject, with brief answers. 3000 w. Gunton's Mag—Dec., 1897. No. 17071 C.

The Monetary Commission. Portraits and sketches of the men who are at work on a plan of currency reform. 4000 w. Bankers' Mag, N. Y.—Dec., 1897. No. 17140 D.

GOVERNMENTAL CONTROL.

Interstate Commerce.

Annual Report of the Interstate Commerce Commission. Gives the principal part of the abstract prepared by the Secretary of the Commission. Deals with rates, powers of the commission, long and short haul, pooling, etc. 3500 w. R R Gaz—Dec. 24, 1897. No. 17414.

"The Long and Short Haul Clause Invalidated." A Criticism. Milton H. Smith. A letter called forth by an editorial on the Alabama Midland decision. 3500 w. Ry & Engng Rev —Dec. 4, 1897. No. 17043.

Railway Legislation.

Prospects for Railway Legislation at Washington. Editorial discussion of bills likely to be brought before Congress, relating to pooling, ticket scalping, freight equipment, etc. 2500 w. R R Gaz—Dec. 16, 1897. No. 17178

LABOR.

Cheap Production.

Automatic Machinery the Secret of Cheap Production. Hiram S. Maxim. Compares the cost of hand work with that of automatic machinery, especially in the cases of gun and bicycle making, and claims the automatic machines benefit labor as well as effect cheap production. 4500 w. Engineering Magazine—Jan., 1898. No. 17395 B.

Engineering Strike.

The Approaching Conference. Editorial comment on the present condition of affairs and the influence on the engineering interests of England. 4000 w. Engng—Nov. 19, 1897. No. 16908 A.

The Engineers' Conference. Report of the points of dispute, giving the respective positions taken by the employers' federation and by the workmen's representatives. 1800 w. Prac Eng —Dec. 10, 1897. No. 17216 A.

Labor Costs.

Comparative Labor Costs. Discussion of this subject with criticisms of the position taken by Mr. Jeans in articles published in the *Engineering Magazine*. 3300 w. Gunton's Mag—Dec., 1897. No. 17072 C.

Labor Demands.

Collective Bargaining. An editorial explanation of the term, and of what trade unionism demands. 2500 w. Engng—Dec. 17, 1897. No. 17419 A.

Mexico.

The Condition of the Laboring Classes in Mexico. Theodore C. Knauff. Excerpts from a lecture delivered at Association Hall, Philadelphia. Interesting account of this country and the conditions affecting the laboring classes. 4200 w. Sci Am Sup—Dec. 18, 1897. No. 17166.

Unions.

Fifty Years of Unionism; A Retrospect. Editorial review of the trade dispute in 1852. Comparison is made, step by step, with the present dispute, showing that they were on similar and parallel lines and that history may repeat itself. 3300 w. Engng—Dec. 10, 1897. No. 17228 A.

United States Mines.

Labor Conditions at the Anthracite Mines of the United States. A review of the history of these mines since 1820, giving information of the workers, wages, accidents, conditions of life, &c. 3500 w. Col Guard—Dec. 10, 1897. No. 17235 A.

Wages.

Fair Wages. Editorial discussion of the report, just issued, by the Select Committee appointed to consider the working of the Fair Wages Resolution, passed by the House of Commons in England. 2500 w Engng—Nov. 26, 1897. No. 17009 A.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Copper Assay.

See Mining and Metallurgy. Copper.

Electric Welding.

The Voltex Process of Electric Welding. Illustrated description of a new process, also applicable to brazing, soldering, or lead burning, recently brought out by G. W. de Tunzelmann. 700 w. Ir & Coal Trds Rev—Nov. 26, 1897. No. 16995 A.

Electrolysis.

The Electrolytic Separation of Cadmium and Zinc, &c. (Die Elektrolytische Trennung von Cadmium und Zink, etc.) With details of methods for separating cadmium and zinc; zinc and cobalt; and antimony and tin. 4500 w. Zeitschr f Elektrochemie—Nov. 20, 1897. No. 17384 B.

The Decomposition of Salt. (Zur Kochsalzzerlegung.) An investigation of the difference between the theoretical and observed voltage, for the decomposition of chloride of sodium. 1000 w. Zeitschr f Elektrochemie—Nov. 20, 1897. No. 17385 B.

Electrolytic Copper.

The Progress of Electrolytic Copper. A general description of the operations necessary for its production, reviewing the history of the subject and the unparaleled growth of this industry. 3500 w. Ind & Ir—Nov. 19, 1897. No. 16914 A.

Electro-Zincing.

Electro-Zincing. Sherard Cowper-Coles. Abstract of a paper read before the Liverpool Engineering Society. Points out the importance of galvanizing and gives an idea of the process of electro-zincing, with a description of the plant employed. Ill. 3500 w. Elec Eng, Lond—Nov. 26, 1897. No. 16997 A.

Iodoform.

The Electrical Production of Iodoform (Ueber die Herstellung von Jodoform auf Elektrolytischem Wege.) Foerster & Meves. Discussing the details of the method producing iodoform by electrolyzing an alcoholic solution of iodide of potassium through which carbonic acid gas is passed. 3000 w. Zeitschr f Elektrochemie—Dec. 5, 1897. No. 17386 B.

LIGHTING.

Arc Lamps.

Enclosed Arc Lamps. Discussion of paper by W. H. Freedman, H. S. Burroughs, and J. Rapaport, on "Efficiency and Life of Carbons in Enclosed Arc Lamps." 4400 w. Trans Am Inst of Elec Engs—Oct., 1897. No. 17080 D.

Tests of an Alternating Current Enclosed Arc Lamp. Illustrated description of some experiments conducted by M. H. Baker, showing how a small variation of voltage causes a large variation of light, and stating the requirements of good service. 1100 w. Elec Wld—Dec. 11, 1897. No. 17045

Astoria Hotel.

See Electrical Engineering, Power.

Brussels.

¶Brussels Electric Lighting Stations. Ernest Kilburn Scott. Describes what is considered to be a model electric light installation. 2400 w. Ind & Ir—Nov. 26, 1897. No. 17026 A.

Distribution.

The Distribution of Electrical Energy in Paris. A summary of report recently presented by M. Charles Bos, municipal councillor, giving much information of electric lighting in France, with comparison with other countries. 2400 w. Elec Rev, Lond—Dec. 17, 1897. No. 17428 A.

Gas Power-Plant.

See Mechanical Engineering, Motors.

Governing.

See Mechanical Engineering, Engines.

Incandescent Lamps.

Life and Candle-Power of Incandescent Lamps. From a recent publication issued by the General Electric Co., showing the folly of using lamps after their candle power has diminished. 3700 w. Elec Wld—Dec. 25, 1897. No. 17252.

The Importance of Quality in Incandescent Lamps. Francis W. Wilcox. Quality of far more importance than first cost. Defines a standard of valuation based on the maintenance of candle power during a given period. 2000 w. Elec Wld—Dec. 11, 1897. No 17047.

Isolated Plants.

Small Lighting Plants. Frederick C. Reeve. Discusses whether lighting companies can materially lower the present rates; whether small plants are practical; and under what conditions they can be made a financial success. 1100 w. Elec Wld—Dec. 4, 1897. No. 16976.

Lighthouses.

See Civil Engineering, Harbors.

Municipal Lighting.

See Municipal Engineering, Miscellany.

Photometry.

Photometric Measurements of Arc Lamps using Alternating Current. (Photometrische Messungen an Wechselstrombogenlampen.) Dr. Wedding. Giving photometric curves from a large number of observations, together with tables showing the relations between current strength and illuminating power. 5000 w. Elektrotechnische Zeitschr—Nov. 25, 1897. No. 17382 B.

Storage Batteries.

One of the Useful Applications of the Storage Battery. William Baxter, Jr. Shows its value as an adjunct to electric-lighting stations. 1300 w. Sci Am—Dec. 18, 1897. No. 17163.

Theatres.

Electricity in the Theatre. George Heli Guy. Reviews the many ways in which electricity is utilized in stage craft. 3500 w. Chau—Dec., 1897. No. 16994 C.

Underground Circuits.

Underground Circuits for Arc Lighting. S. H. Sharpsteen. Notes from the experience of the writer. 2400 w. Elec Eng, N. Y.—Dec. 2, 1897. No. 16943.

Washington, D. C.

The New Plant of the United States Electric Lighting Company at Washington, D. C. George H. Draper. Description of a modern station and its equipment. 3000 w. Elec Rev, N. Y.—Dec. 22, 1897. No. 17244.

POWER.

Astoria Hotel, New York.

The Electric Plant of the Astoria Hotel. Illustrated detailed description of this interesting isolated plant, which probably carries the greatest load of any isolated plant in existence. The lamps number over 25000, besides 21 electric elevators, and an amount of auxiliary electrically driven apparatus. 3800 w. Elec Wld—Dec. 25, 1897. No. 17250.

Bradford, Eng.

Bradford Corporation Electricity Supply. Robert Porter. Read before the Manchester District Institution of Gas Engineers. Descriptive of the Bradford electricity works. Followed by discussion. 3800 w. Jour of Gas Lgt—Nov. 30, 1897. No. 17058 A.

Central Stations.

The Tendency of Central Station Development. Part first discusses the distribution systems, and the changes of the last few years. 2000 w. Elec Wld—Dec. 4, 1897. Serial. 1st part. No. 16977.

Electrical Equipment.

The Electrical Equipment of the American Lithographic Company Building, New York City. Illustrated detailed description of a well-designed plant. 4500 w. Elec Eng, N. Y.—Dec. 30, 1897. No. 17461.

Dynamos.

Alternating-Current Dynamo Tests. Horace Field Parshall. From the *Proceedings of the Institution of Civil Engineers*, England. Investigations made to determine efficiency at different loads, to obtain quantitative results, and to establish an economical, accurate and comprehensive method of testing. 4000 w. Elec Eng, Lond—Dec. 17, 1897. No. 17432 A.

Compound Dynamos and Their Action. James T. Jennings. Information regarding the action of compound-wound generators working in multiple. 1800 w. Am Elect'n—Dec., 1897. No. 16988.

Electric Hauling.

An Electrically-Driven Hauling Plant. From a communication by N. Phillippi, to the *Berg- und Hüttenmännische Zeitung*. Illustrated detailed description of the plant at the Kaiserin Auguste pit of the Gottessegen Colliery. Ill. 2800 w. Col Guard—Nov. 19, 1897. No. 16-922 A.

Electric Launch.

See Marine Engineering.

Fire Risk.

The Fire Risk of Electrical Power Installations. A. Lester Taylor. Read before the Manchester (Eng.) Insurance Institute. Notes the rapid extension in the use of electric power, with consideration of the additional fire risk, reviewing the experience, and the precautions necessary. 5800 w. Elec Rev, Lond—Dec 17, 1897. No. 17430 A.

Flushing, N. Y.

The Flushing, L. I., Electric Light and Power Station. Illustrated detailed description of a small plant, the characteristic of the service being an extremely low load factor. 2300 w. Elec Eng, N. Y.—Dec. 2, 1897. No. 16942.

Gas Power Plant.

See Mechanical Engineering. Motors.

Generators.

Regulation of Field Current in a Three-Phase Generator Working Singly with a Widely Varying Motor Load, also Three-Phase Motors in Practice. Arthur H. Gibson. Suggests a device for overcoming the difficulty. 700 w. Elec Rev, Lond—Dec. 3, 1897. No. 17122 A.

Setting Up Large Generators. George T. Hanchett. Points on the setting of a dynamo of the direct-connected multipolar type. Attention is called to faults of these machines. Ill. 2500 w. Elec Wld—Dec. 4, 1897. No. 16975.

Hoisting Machinery.

Electric Lifts and Cranes. H. W. Ravenshaw. Read before the Institution of Civil Engineers, England. The object is to direct attention to electrical and mechanical problems which present themselves in the application of electric motors to lifts and cranes, and to describe methods by which they have been solved in particular cases. Ill. 1800 w. Elect'n—Nov. 19, 1897. Serial. 1st part. No. 16925 A.

Hydraulic Power Plant.

Water Power and Electric Plant at the Adda Rapids, Near Paderno, Italy. Illustrated detailed description. 2200 w. Elec Eng, N. Y.—Dec. 9, 1897. No. 17067.

Hydraulics.

See Mechanical Engineering, Power and Transmission.

Induction.

Steinmetz on Induction Motors. Discussion of paper read by Charles P. Steinmetz, at Eliot, Me. 3000 w. Trans Am Inst of Elec Engs—Oct., 1897. No. 17073 D.

Induction Motors.

A Simple Method of Starting Alternating Single Phase Induction Motors. Riccardo Arno. A paper read before the Associazione Elettro-technia Italiana. 1700 w. Elec Rev, Lond—Nov. 26, 1897. No. 17016 A.

Power House.

See Street and Electric Tramways.

Regulator.

Water-Wheel Regulation. Samuel N. Knight. Refers to methods in use, stating why they are objectionable and describes apparatus adopted by the writer. 1700 w. Jour of Elec—Nov., 1897. No. 17050.

Rheostats.

Practical Use of Water Rheostats. Edward J. Willis. Also, A Note on Water Rheostats. E. A. Merrill. A few points and suggestions to those who have charge of such work. 2800 w. Am Elect'n—Dec., 1897. No. 16987.

Shop Driving.

Electric Power Work in Ironworks, Shipyards and Engineering Establishments. Abstracts of papers read at meeting of the Cleveland Inst. of Engineers, held at Middlesborough. 3000 w. Col Guard—Nov. 19, 1897. No. 16919 A.

Starting.

Concerning Starting Resistance for Motors. (Ueber Anlasswiderstande für Nebenschlussmotoren.) A paper by Herr Menges describing a method of introducing a starting resistance which is afterwards short circuited. 1500 w. Electrotech Zeitschr—Dec. 2,1897. No.17383. B.

Stations.

The Lighting and Power Stations of the Richmond Railway and Electric Company. Illustrated detailed description of a plant of interest as an example of the evolution of practice during the last fifteen years. 1600 w. Elec Wld—Dec. 4, 1897. No. 16974.

Steam Engines.

See Mechanical Engineering. Engines.

Subdivision.

The Subdivision of Alternating Currents by Means of Transformers. (Verteilung von Wechselstrom mittels Transformatoren.) Showing the relative efficiency of transformers, and describing the Schlatter transformer system. 2500 w. Elektrotechnische Rundschau—Dec. 1, 1897. No. 17389 B.

Towing.

Trolley Connection and Locomotive for Towing Canal Boats. Describes the invention of Frederick J. Shewring ; also the device invented by Edwin A. Leland. Ill. 700 w. Elec Eng, N. Y.—Dec. 23, 1897. No. 17264.

Transformers.

Alternate Current Transformer Design. The article is a conclusion to a series of articles recently published in this paper, and gives a worked example of a simple design. Ill. 800 w. Elec, Lond—Dec. 10, 1897. Serial. 1st part. No. 17192 A.

Transmission.

The Newcastle - Sacramento Transmission Plant. Illustrated detailed description. 2300 w. Elec Wld—Dec. 18, 1897. No. 17143.

The Transmission of Energy to a Distance. (Sur la Transmission d'Energie à Distance.) A mathematical discussion of the application of rotary polarisation, by M. André Broca ; presented to the French Academy by M. Cornu. 1000 w. Comptes Rendus—Nov. 15, 1897. No. 17317 D.

TELEGRAPHY AND TELEPHONY.

Fire Alarm.

The Montauk Multiphase Fire Cable. Illustrates and describes an ingenious system of fire alarm. 800 w. Sci Am—Jan. 1, 1897. No. 17462.

Galvanoscope.

Use of the Telephone as a Galvanoscope. George I. Hanchett. Shows modifications in the use of this instrument in testing, and indicates where it can be used to greater advantage than a galvanometer. Ill. 2000 w. Elec Eng, N. Y.—Dec. 23, 1897. No. 17263.

Glasgow.

The Glasgow Telephone Inquiry. An account of the recent inquiry into the causes of dissatisfaction with the service. 3800 w. Elec Eng, N. Y.—Dec. 16, 1897. No. 17147.

Police Service.

An Important System of Police Telephone Service for New York City. The McCullagh Plan. Brief detail of plan suggested by Chief John McCullagh for establishing permanent ports and police intercommunication, to increase the efficiency of the police force. 2000 w. Elec Eng, N. Y.—Dec. 16, 1897. No. 17148.

Statistics.

Telegraphic Statistics. A translation from the *Journal Télégraphique* relative to the progress of the various countries in telegraphic developments. 3000 w. Elec Eng, Lond—Dec. 3, 1897. No. 17159 A.

Telephone System.

Switch System for Telephone Exchange. (Schaltung für Gemeinschaftliche Fernsprechleitung.) A method of using a number of telephones upon a single wire; all but the one in use being automatically disconnected. Suitable for small systems. 1500 w. Elektrotechnische Zeitschr—Nov. 18, 1897. No. 17381 B.

Wireless Telegraphy.

Marconi Telegraphy. Description of the experiments made in Berlin and Vienna. Ill. 1400 w. Elec Rev, Lond—Dec. 3, 1897. No. 17121 A.

Signalling Through Space Without Wires. W. H. Preece. An address given before the Royal Institution. An interesting lecture giving a description of the method applied by the author, and also the method of Hertz used by Mr. Marconi. The first method utilizes electromagnetic waves of very low frequency ; the second utilizes waves of very high frequency. Ill. 3500 w. Science—Dec. 17, 1897. No. 17180.

The Electrical Conductivity of Interrupted Conductors. (Sur la Conductibilité Electrique des Substances Conductrices Discontinus.) M. E. Branly. An account of experiments made in 1891-92 with coherers similar to those used by Marconi in wireless telegraphy. 1000 w. Comptes Rendus—Dec. 6, 1897. No. 17325 D.

Zerograph.

The Zerograph. Illustrated detailed description of a new instrument for doing the work of a type-printing telegraph. 1100 w. Elect'n—Nov. 19, 1897. No. 16924 A.

MISCELLANY.

Alternators.

Determination of the Virtual Electromotive Force of Alternators. Karsten Knudsen. A consideration of the practical applications of the magnetic field, and the electromotive forces set up in conductors when moving in a field of definite strength. 1200 w. W Elect'n—Dec. 11, 1897. Serial. 1st part. No. 17146.

Armatures.

Goldsborough on Armature Inductance. Discussion of paper by W. E. Goldsborough on "The Effect of Armature Induction upon the Electromotive Force Curves of an Alternator." 1700 w. Trans Am Inst of Elec Engs—Oct., 1897. No. 17076 D.

Condensers.

Macfarlane on Discharge of Condenser. Discussion of paper read May 18, 1897. 3800 w. Trans Am Inst of Elec Engs—Oct., 1897. No. 17074 D.

Converter.

Armature Reaction in a Rotary Converter. Discussion of paper by Robert B. Owens. 4400 w. Trans Am Inst of Elec Engs—Oct., 1897. No. 17081 D.

Currents.

The Alternating Current. Lawford H. Fry. An attempt to make clear the occurrences in a circuit carrying an alternating current of electricity, without using complicated mathematical formulæ. 2500 w. Am Mach—Dec. 23, 1897. No. 17275.

Three-Phase Current Measurement. Lawford H. Fry. Describes the method in use in the electrical laboratory of the Hanover Polytechnikum. It is simple and very economical in the number of instruments required, and in the time needed for a measurement. Ill. 800 w. Elec Rev, Lond—Dec. 10, 1897. No. 17213 A.

Electrical Discharges.

Electrical Discharges in Vacuo. J. Warren. Part first gives explanation of phenomena appearing in the discharges in vacuum tubes. 1700 w. Elec, Lond—Dec. 17, 1897. Serial. 1st part. No. 17427 A.

Electric Heating.

A Practical Application of Electric Heating.

Illustrated description with general particulars relating to the plant in the straw-hat factories of Wm. Carroll & Co , located at Matteawan, N. Y. 1400 w. Am Elect'n—Dec., 1897. No. 16985.

Electrical Measurements.

Electrical Measurement by Alternating Currents. Henry A. Rowland. Treats mainly of inductances, self and mutual, and of capacities together with their ratios and values in absolute measure as obtained by alternating currents. 5500 w. Am Jour of Sci—Dec., 1897. No. 16963 D.

Electric Welding.

The History of Electric Welding. A. J. Moxham. An account of the process and its progress, the laws governing the work and their adaptation to commercial practice. 3000 w. Ir Age—Dec. 30, 1897. No. 17472.

Induction.

Some Experiments on Induction with Currents of High Frequency at Long Distance. Edwin F. Northrup, George W. Pierce and Fritz Reichmann. An account of some experiments showing the subtle action of the ether and the power of resonance in electrical circuits. Ill. 1800 w. Elec. Wld. Dec. 18, 1897. Serial. 1st part. No. 17145.

The Action of Induction Apparatus. (Ueber die Vorgänge in Induktionsapparat.) An account of the investigations of Herr Walter, at Hamburg, into the relation between the condenser capacity and length of spark in induction coils. 1800 w. Elektrotechnische Rundschau —Nov. 15, 1897. No. 17388 B.

Insulation.

Bates and Barnes on Insulating Materials. Discussion of paper on "The Effect of Heat Upon Insulating Materials," by Putnam A. Bates and Walter C. Barnes. 4800 w. Trans Am Inst of Elec Engs—Oct., 1897. No. 17075 D.

High Potential Insulators. Frederic A. C. Perrine. A careful examination of the necessary details in the manufacture of porcelain for insulators and the need of careful study of material and form. 4200 w. Elec Engng—Dec. 15, 1897. No. 17249.

Isolated Plants.

Does It Pay to Generate Electricity or Buy It? An examination of this subject for the purpose of laying down some general rules under which separate plant would be justified. 1300 w. Mach, Lond—Dec. 15, 1897. No. 17426 A.

Lightning Protection.

I. Lightning on Transmission Lines. Theo. E. Theberath. II. Lightning at Sacramento. C. W. Hutton. III. Lightning in Nevada County. E. J. De Sabla, Jr. IV. Lightning and Long Transmission. E. W. Sutcliffe. V. Insulators for Transmission Lines. John Martin. Papers read before the Sacramento convention of the Pacific Coast Electric Transmission Assn. 10000 w. Jour of Elec—Nov., 1897. No. 17051.

Magnetism.

Recent Researches in Terrestrial Magnetism. A. W. Rücker. The "Rede Lecture" delivered in the Senate House, Cambridge, Eng. Presents some of the theories and speculations which are now attracting the attention of those interested in this science. 4400 w. Nature—Dec. 16, 1897. Serial. 1st part. No. 17433 A.

Metering.

Haskins on Electric Metering. Discussion of paper by Caryl D. Haskins on "Electric Metering from the Station Standpoint." 3700 w. Trans Am Inst of Elec Engs—Oct., 1897. No. 17077 D.

Ohm.

On a Determination of the Ohm made in Testing the Lorenz Apparatus of the McGill University, Montreal. W. E. Ayrton and J. V. Jones. A mean of 9 measurements, when carefully corrected, shows that 1 Board of Trade Ohm equals 1.00026 true ohms. The details of the tests are given. 2500 w. Ind & Ir—Nov. 19, 1897. No. 16912 A.

Resistance.

Our Knowledge of the Value of a Resistance. W. E. Ayrton. Considers the degree of accuracy with which the resistance of any particular conductor may be stated in absolute measure, at the present time. 2000 w. Elect'n, Lond—Nov. 26, 1897. No. 17029 A.

Roentgen Rays.

Experiments with Cathode and Röntgen Rays. J. Precht. Abstracted from *Wiedmann's Annalen*. Considers the deviation of cathode rays by a magnet and the properties of rays emerging from discharge tubes, giving experiments. Ill. 1600 w. Elec Wld—Dec. 18, 1897. No. 17144.

Shielding.

On Magnetic Shielding. H. Du Bois. Part first is somewhat introductory, explaining what has been accomplished, and the need of a fuller treatment of the subject. Gives also the theory of spherical and cylindrical bi-lamellar sheaths. 1700 w. Elect'n, Lond—Dec. 10, 1897. Serial. 1st part. No. 17227 A.

The Magnetic Shielding of Conductors of Electricity. Ernest Wilson. Describes experiments made by the author, with the object of getting a practical demonstration of the disturbances to be dealt with under different conditions. 1600 w. Elect'n, Lond—Dec. 17, 1897. No. 17424 A.

Sparking.

Sparking, Its Cause and Effects. Thorburn Reid. Read before the Am. Inst. of Elec. Engs. Considers the real injury is done before the segment leaves the brush. A study of commutation. 2500 w. Elec Rev, N. Y.—Dec. 22, 1897. Serial. 1st part. No. 17245.

Stress.

See Mining and Metallurgy, Iron and Steel.

Testing.

A New Magnetic Testing Apparatus. Robert B. Treat and J. Walter Esterline. Illustrated description of apparatus designed and constructed by the authors, at the laboratories of Purdue University, Lafayette, Ind. 1300 w. Elec Wld—Dec. 11, 1897. No. 17046.

Training.

How to Become an Electrical Engineer. George B. Lauder. First prize letter in the competition inaugurated by this paper. 1700 w. Elec Rev, N. Y.—Dec. 8, 1897. No. 17048.

Transformer.

The Ferraris-Arno Phase Transformer. (Phasen-transformator nach Ferraris-Arno.) Dr. Lombardi. A special form of motor transformer composed of a single phase alternating motor with auxiliary winding system, by means of which the amount and phase of the induced current is determined. Two articles. 6000 w. Elektrotechnische Zeitschr—Nov. 18, Dec. 2, 1897. No. 17380 E.

X Rays.

Apparatus for Determining the Position of Projectiles in the Skull. (Appareil Destiné à Determiner la Position des Projectiles dans le Crâne.) The method of MM. Remy and Contremoulins, presented to the French Academy by M, Marey consists in the use of two Crookes tubes, to make radiographs from known positions. 1500 w. Comptes Rendus—Nov. 22, 1897. No. 17319 D.

Gold-Foil Screens for X-Ray Practice. J. Elliott Woods. Further experiments with defence of previous arguments. 2000 w. Elec Rev, N. Y.—Dec. 1, 1897. No. 16941.

New System for Locating Bullets. Illustrates and describes a method, aided by radiographic proofs, which has proved most successful. 2400 w. Sci Am Sup—Dec. 25, 1897. No. 17265.

The Discharge of Electrified Bodies by the X Rays. Clement D. Child. Reviews briefly articles already published on this subject, and gives experimental work. 5500 w. Phys Rev—Oct., 1897. Serial. 1st part. No. 16300 D.

MARINE ENGINEERING.

Balancing.

The Yarrow-Schlick-Tweedy System of Balancing Engines. Several illustrations showing the results attained in the twin-screw steamship Avon, and in others, by the adoption of this system, with explanations. 1300 w. Engng—Dec. 17, 1897. No. 17417 A.

Battleships.

The Engineer and His War-Engine. R. H. Thurston. Traces the work of development in the modern war-vessel and discusses the relation of the personnel, the need of increasing the number of engineer officers, &c. 4200 w. N Am Rev—Dec., 1897. No. 16950 D.

Cellulose.

A New Form of Cellulose. E. L. Freeland. On the process, invented by Mark W. Marsden, utilizing the pith of cornstalks as an absorbent for water entering through shot-holes. The advantages are presented. 1200 w. Yale Sci M—Nov., 1897. No. 16932 C.

Electric Launch.

Electric Launch for the Czar of Russia. Gives dimensions and construction, fittings and furnishings and electrical equipment of this boat being built by the Electric Launch Co., of New York. Ill. 1300 w. Elec Eng, N. Y.—Dec. 16, 1897. No. 17149.

Fans.

Centrifugal Fans as Applied to Marine Uses. G. M. Capell. Read before the Institute of Marine Engineers, at Stratford. Reviews the improvements in the last fifteen years in the construction of fans and their use in mines as well as marine uses. 2200 w. Engs' Gaz—Dec., 1897. No. 17053 A.

Fishing Vessels.

The Ocean Fisheries and the Professional Instruction of Mariners. (Les Pêches Maritimes et l'Enseignement Professionnel des Marins.) M. Perard. A discussion of the commercial value of the North Sea fisheries and an account of the construction of the fishing vessels, and the schools for instruction of fishers in France. 10000 w. Bulletin de la Société d'Encour—Nov., 1897. No. 17349 F + G.

Gunboats.

Light-Draught Gunboats for the United States Navy. Description of the Nashville, Wilmington and Helena as representing a class intended for special duty in shallow bays and rivers. Ill. 2500 w. Engr, Lond—Dec. 3, 1897. No. 17124 A.

Loading.

Loading of Vessels Engaged in "Klondike" Trade on the Pacific Coast. James S. Tyler. An account of the arrangements made to meet the sudden increase in passenger and freight traffic. 2000 w. Marine Engng—Dec., 1897. No. 17142 C.

Marine Machinery.

Estimated Weights of Marine Machinery. George R. McDermott. Abstract of paper read at meeting of the Society of Naval Architects and Marine Engineers. Gives the result of investigations made regarding methods for determining the weights of machinery of steamships. 2300 w. Sib Jour of Engng—Dec., 1897. No. 17247 C.

Propellers.

On the Influence of Surface on the Performance of Screw Propellers. W. F. Durand. Read before the Society of Naval Architects and Marine Engineers, New York. Illustrated description of investigations, the essential feature being the relation of the amount of area of the blade to the performance as a whole. 6000 w. Marine Engng—Dec., 1897. No. 17141 C.

Something About Screw Propellers. John H. Meyer. A study of the action and the effect is given in part first. Ill. 1400 w. Engr, N. Y.—Dec. 1, 1897. Serial. 1st part. No. 17031.

Roller Boat.

The Theories Upon which the Knapp Roller Boat was Built. Robert W. Rayson. The idea was to obtain the greatest contact with the water and therefore the greatest resistance, because this tends to lift the boat out of her displacement and decrease the power necessary to acquire speed. 1500 w. Sci Am—Dec. 18, 1897. No. 17164.

Salvage.

The Raising of the Four Master "Europe." (Remise à Flot du Navire Quatre-Mats "Europe.") Describing the righting of a steel vessel of 3500 tons displacement which had been grounded and capsized by an unexpected tidal change. An important and valuable paper. 3500 w. La Revue Technique—Dec. 10, 1897. No. 17311 D.

Shipbuilding.

Shipbuilding as a Productive Industry in Great Britain. James McKechnie. Showing the reciprocal influence of private enterprise and naval dominion with especial reference to the growth of ship-building on the Clyde and at Barrow subsequent to the Naval Defense Act. 4000 w. Engineering Magazine—Jan., 1898. No. 17393 B.

Comparison and Construction of Ships' Lines. Archibald Hogg. Read before the Northeast Coast Inst. of Engineers and Shipbuilders, at Newcastle-on-Tyne. Illustrates a method of comparison and construction of the under-water part of a ship's hull. 2800 w. Ind & Ir—Nov. 19, 1897. No. 16913 A.

Torpedo Boats.

The Stranding of the "Thrasher." Interesting illustrations showing the damage sustained by this torpedo-boat destroyer, which ran ashore on the rocks of Dodman Point, with comments. 1800 w. Engng—Nov. 26, 1897. No. 17010 A.

Twin-Screw Steamer.

The Carron Company's T. S. S. "Avon.' Illustrated description. 1500 w. Engng—Nov. 19, 1897. No. 16910 A.

Unloading.

A Contractor's Movable Landing Stage. Describes an arrangement used by F. H. Hebblethwaite in unloading a quantity of material from vessels in Manaos, in the Rio Negro, Brazil. 1300 w. Eng Rec—Dec. 4, 1897. No. 17039.

Yachts.

Notes on the Yacht Defender and the Use of Aluminum in Marine Construction. Richmond Pearson Hobson. Extract from a paper contributed to the United States Naval Institute. Deals with corrosion, and the importance of aluminum in marine construction. 2000 w. Sci Am Sup—Dec. 18, 1897. No. 17165.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Boiler Management.

On the Management of Steam-Boilers. F. G. Ansell. Considers how to ensure full efficiency and avoid all possible risk of danger, discussing firing and feed-water. 3200 w. Elec Eng, Lond—Dec. 10, 1897. No. 17222 A.

The Management of Boilers and Steam Plant, Including Details of Steam Pipes and Fittings. A. B. Mountain. Read before the Northern Society of Electrical Engineers, at Manchester, Eng. The author's experience with various types of steam generators is given and consideration of details named. 5500 w. Ind & Ir—Dec. 17, 1897. No. 17455 A.

Circulation.

A Study of the Circulation of Water in Multitubular Boilers. (Etude de la Circulation de l'Eau dans les Chaudières Multitubulaires.) H. Brillié. A discussion of the circulation in water-tube boilers comparing the theories of English, American and French engineers, and a mathematical investigation based on experimental data. Serial. Part I. 4000 w. Le Génie Civil—Dec. 4, 1897. No. 17306 D.

Explosions.

Accidents Caused by the Rupture of Boiler Flues. (Accidents Causés par des Ruptures de Tubes à Fumeé.) M. C. Walckenaer. Report of the secretary of the central commission of steam machinery (France) with discussion of the failures of boiler flues from 1888 to 1896. 7500 w. 1 plate. Ann des Ponts et Chaussées—Part III. 1897. No. 17346 F + G.

A Terrible Boiler Explosion and Its Lesson. An account of the explosion which occurred Nov. 22, at the Graves Elevator Works, Rochester, N. Y. The cause is supposed to have been a crack hidden in the joints by the over-lap of the sheets. 1800 w. Am Mach—Dec. 16, 1897. No. 17160.

Explosion of a Marine Boiler. (Explosion eines Schiffskessels.) With very clear photographs showing the ruptured rear end of the cylinder. The metal was found to be crystallized. 1000 w. Zeitschr d Ver Deutscher Ing—Nov. 27, 1897. No. 17335 D.

Fireboxes.

Staying of Locomotive Fireboxes. A discussion of this subject, dealing with fireboxes made in accordance with English practice, with internal plates of copper and exterior shell plates of iron or steel, the material used for the stays being copper. 2300 w. Engng—Nov. 19, 1897. Serial. 1st part. No. 16909 A.

Forced Draught.

The Meldrum System of Forced Draught. Describes and illustrates this system,of ash pit steam jets and states the advantages that accrue from its adoption. 1500 w. Ry Wld—Dec., 1897. No. 17211 A.

Frost Damage.

Damage to Steam Boilers by Frost. Examples are given showing that even boilers built of heavy plate and tested at high pressure cannot be exposed to cold weather with impunity. Ill. 500 w. Power—Dec., 1897. No. 17201.

Injectors.

A Comparative Test of Steam Injectors. George Henry Trautmann. A thesis submitted for the degree of Bachelor of Science in Mechanical Engineering, University of Wisconsin. Comparative tests of a number of well-known makes. Ill. & tables. 2500 w. Bul of Univ of Wis—No. 12. No. 17082 C.

The Injector. M. W. Roe. Describes the mechanism and action of the injector, and reports a test. 1200 w. Sib Jour of Engng—Dec., 1897. No. 17248 C.

Lancashire Boiler.

Specifications for a Lancashire Boiler 30 ft. x 8 ft., for 200 lb. Working Pressure. Sam Boswell. Points out the main features and gives dimensions and details. 1300 w. Prac Eng—Dec. 17, 1897. No. 17453 A.

Smoke.

The Smoke Nuisance and its Regulation, with Especial Reference to the Condition Prevailing in Philadelphia--Improved Furnaces and Mechanical Stokers. Illustrated detailed description of the construction and operation of various stokers and furnaces. 8000 w. Jour Fr Inst—Dec., 1897. Serial. 1st part. No. 17094 D.

Stay Bolts.

Pneumatic Stay-Bolt Breaker, Atchison, Topeka and Santa Fé Railway. Illustrated description of the invention of John Player, by use of which the removal of the inner shell of the fire box from a locomotive boiler becomes a simple operation. 1200 w. Ry & Engng Rev—Dec. 18, 1897. No. 17239.

Strains.

The Strains on Cover-Plate Bolts. From the *Locomotive.* Extracts from an article studying the tension to which the bolt is subjected when under steam. 1000 w. Bos Jour of Com—Dec. 25, 1897. No. 17290.

Vacuum Pan.

Apparatus for Boiling Sirup. (Appareil pour Cuire les Sirops.) Illustrated description of the Ehrenstein evaporating pans and sugar filters. The evaporation is effected by high pressure steam coils in vacuum pans. 1000 w. 1 plate. Le Génie Civil—Nov. 13, 1897. No. 17301 D.

Water-tube Boiler.

Water-Tube Boilers, H. M. S. Salamander. Describes a new water-tube boiler made for this English torpedo-destroyer. 1300 w. Engr, Lond—Dec. 3, 1897 No 17126 A.

COMPRESSED AIR.

Cold Storage.

Cold Storage and Cold Rooms from Compressed Air. G. D. Hiscox. An explanation of the conditions of air expansion applied to the practical effects of refrigeration, with diagram showing much that is interesting in regard to the general conditions. 1800 w. Compressed Air—Dec., 1897. No. 17277.

Cooling.

Regulating Temperature of Buildings by Compressed Air. Presents a plan showing in detail the system employed by the Davis & Roesch Co. of New York. Ill. 500 w. Compressed Air—Dec., 1897. No. 17279

Explosions.

Explosions in Air-Compressors. From an article by F. Strnad in *Gluckauf.* A discussion of the causes and remedies of explosions, giving details of explosions in Europe. In cases cited an explosive mixture of air and oil vapor were ignited by the heat of compression. Gives precautionary measures. 2800 w. Col Guard—Dec. 10, 1897. No. 17231 A.

Foundry Plant.

A Model Compressed Air Foundry Plant. H. M. Perry. Illustrated description of a foundry crane in the works of John J. Radley & Co., New York. 600 w. Compressed Air—Dec., 1897. No. 17278.

Haulage.

Mechanical Haulage by Compressed Air. E. P. Lord. Abstract of a paper read at a meeting of the Anthracite Coal Operators' Assn., New York. Presents its advantages over other classes of haulage, and gives information relating to the installation and operation of the plant. 4500 w. Col Guard—Nov. 26, 1897. No. 17025 A

Hydraulic Compressor.

Hydraulic Plant for Compressing Air. H. D. Pearsall. Read at meeting of Manchester (Eng.) Assn. of Engineers. The author confines his attention to those hydraulic air compressors which have attempted to apply the water directly. 3600 w. Col Guard—Dec. 3, 1897. No. 17155 A.

Pneumatic Transmission.

Pneumatic Mail-Tube System, New York City. Illustrated description of the installation, and the method of operation, with historical account of its use in other cities. 3400 w. Sci Am—Dec. 11, 1897. No. 17064.

ENGINES AND MOTORS.

Condensers.

Ejector Condensers v. Jet Condensers and Air Pumps. Illustrated description of the ejector condenser and a statement of its advantages. 900 w. Prac Engr—Nov. 26, 1897. No. 17028 A.

Expansion Engines.

Expansion Engines for Land Service. W. H. Hoffman. A lecture before the Massachusetts Assn. of Steam Engineers. Considers compound, triple and quadruple expansion engines, and gives suggestions helpful to those in charge. Ill. 1700 w. Elec Eng, N. Y.—Dec. 9, 1897. No. 17068.

Friction.

Note on the Variations of Frictional Resistance in Steam Engines. (Ein Beitrag zur Beurteilung der Zusätzlichen Reibung bei Dampfmaschinen.) A discussion of the conditions under which the friction increases and diminishes with the variations of the load upon the engine. 2500 w. Zeitschr d Ver Deutscher Ing—Nov. 20, 1897. No. 17331 D.

Gas Engines.

Gas and Gasolene Engines. E. W. Roberts. Their adaptability to mining work and their merits compared with other motors are discussed, with a description of the uses to which they may be applied and the conditions under which they insure efficiency, economy and convenience in mines. Ill. 4000 w. Mines & Min—Dec., 1897. No 17170 C

Gas and Petroleum Engines at the Brussels Exhibition. Some interesting information with illustrated description of engines contributed by British makers. 1400 w. Engng—Nov. 19, 1897. Serial. 1st part. No. 16907 A.

The Application of Furnace Gases for Motive Power. (Die Verwendung der Hochofen Gichtgase zur Erzeugung Motorischer Kraft.) Showing that better economy is obtained by using furnace gases in gas engines than by burning them under steam boilers. A review of the experiments at Liège. Two articles. 7500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 30, Nov. 6, 1897. No. 17373 E.

The Economy and Efficiency of the Large Gas Engine. Dugald Clerk. A review of the latest practice by a pioneer in this field with many illustrations of large engines. The prediction is made that gas engines as powerful as any steam engines will be built. 4000 w. Engineering Magazine—Jan., 1898. No. 17397 B.

The Petroleum, Gas and Naphtha Motors at the Nijni-Novgorod Exposition, 1896. (Die Petroleum,—Gas,—und Napthamotoren der Ausstellung in Nischniji-Nowgorod, 1896.) A variety of explosion motors were shown, including several portable petroleum motors for agricultural use. 4000 w. Zeitschr d ver Deutscher Ing—Nov. 20, 1897. No. 17330 D.

Gas Power Plant.

Gas-Producing Plant and Gas-Engines for Electricity Works. Report by Prof. Henry Robinson on the Leyton Urban District Council's electricity station, giving information of interest to those who are concerned in deciding as to the relative merits of steam and gas plants. 2500 w. Elec Eng, Lond—Dec. 10, 1897. No. 17223 A.

The Leicester Gas-Power Electric-Lighting Station of the Midland Railway. Particulars as to the equipment and working of this station, which is one of the most successful in England. Ill. 1100 w. Elect'n, Lond—Dec. 17, 1897. No. 17425 A.

Governors.

Engine Governors. R. H. Smith. Part first explains the need of varying the design and operation of governors to suit the machine to which they are applied; also considers the whole operation of governing. 4500 w. Engr, Lond—Nov. 26, 1897. Serial. 1st part. No. 17017 A.

On Methods of Testing Engine Governing. F. W. Roller. Explanation of the methods of testing how well the governors of steam engines for electric work fulfil their purpose. Ill. 2400 w. Am Elect'n—Dec., 1897. No. 16986.

Heat Motor.

Diesel's Rational Heat Motor. From *Zeitschrift des Vereines Deutscher Ingenieure.* Translation of a lecture delivered by Rudolph Diesel, with illustrations and tables. Also editorial. 4000 w. Pro Age—Dec. 1, 1897. Serial. 1st part. No. 16945.

Indicator.

Little's Continuous Recording Indicator. Illustrated description of an instrument capable of integrating continuously the work done in the cylinder of an engine under all conditions of varying load, explaining the theory. 2700 w. Engng—Dec. 10, 1897. No. 17229 A.

Indicator Diagrams.

The Commercial Value of Indicator Diagrams. Sidney R. Lowcock. Read before the South Staffordshire Institute of Iron and Steel Works Managers. Showing that diagrams, when properly taken, furnish a complete record of what takes place in the engine cylinder, and enable one to decide what steps to take to improve the economy. 1300 w. Col Guard—Nov. 26, 1897. No. 17023 A.

Pumping Engine.

Triple Expansion Pumping Engine for the City of Mexico. Front and side elevation of the engine and pumps, with brief description and report of fine record made in the shipment from Lockport, N. Y. 700 w. Eng News—Dec. 2, 1897. No. 16990.

Regulator.

See Electrical Engineering, Power.

Steam Engines.

Steam Engine Construction and its Relation to Electrotechnics. (Der Dampfmaschinenbau und Seine Beziehungen zur Elektrotechnik.) A general discussion by Prof. Gutermuth of the modifications which have been wrought in engine construction by the demands for electrical service. 7000 w. Zeitschr d Ver Deutscher Ing—Dec. 11, 1897. No. 17337 D.

Valve Gear.

The Proell-Corliss Engine and the Proell Valve Diagram. Hermann Kuhne. Read before the Inst. of Engineers and Shipbuilders in Scotland, Oct. 26, 1897. Illustrated description of the Proell expansion apparatus, and the engine named. 1300 w. Prac Eng—Dec. 10, 1897. No. 17217 A.

POWER AND TRANSMISSION.

Friction Wheels.

Experiments with Friction Wheels. (Versuche mit Reibrädergetrieben.) Describing a number of tests made with metal disk friction wheels, with wheels of paper, wood and cast iron; and with the Sellers variable friction gear. An electric motor furnished the power, and the measurements were made with a Prony brake. 1200 w. Zeitschr d Ver Deutscher Ing—Nov. 27, 1897. No. 17336 D.

Grain Elevator.

Grain Elevator in Copenhagen. Translated from *Oesterreichische Monatsschrift für den Oeffentlichen Baudienst.* Illustrated description. 1000 w. Sci Am Sup—Dec. 4, 1897. No. 16973.

Hydraulics.

Hydraulic Problems. W. Stuart Smith. Read before the Sacramento convention of the Pacific Coast Electric Transmission Assn. The difficulties that arise in the development of a water power. 3800 w. Jour of Elec—Nov., 1897. No. 17049.

Motive Power.

Steam, Gas, and Electrical Energy as Applied to Chemical Works. F. H. Bowman. Read before the Manchester Section of the Society of Chemical Industry. Abstract of views on each power named is given. 1200 w. Gas Wld—Dec. 11, 1897. No. 17221 A.

Safety Coupling.

The Viviez Automatic Safety Coupling. (Selbstthätige Sicherheitskupplung von Viviez.) An automatic coupling for rolling-mill use, which will release the connection under excessive strains before breakage can occur. 600 w. Zeitschr d Ver Deutscher Ing—Nov. 13, 1897. No. 17329 D.

Steam Power.

Foster on Cost of Steam Power. Discussion of paper by H. A. Foster, read July 28, 1897. 3300 w. Trans Am Inst of Elec Engs—Oct., 1897. No. 17079 D.

See Mining and Metallurgy, Mining.

Water Motors.

Making Practical Water Motors. George D. Rice. Describes and illustrates three new forms of these machines. 800 w. Dom Engng—Dec., 1897. No. 17268 C.

Water Power.

The Motive Power of the Arc. (Les Forces Motrices de l'Arc.) Giving an illustrated description of the various power stations which utilize the force of this mountain torrent of upper Savoy between Modena and Saint-Michel. 3500 w. La Revue Technique—Nov. 25, 1897. No. 17308 D.

Windmills.

Power of a Twelve Foot "Power" Windmill. E. C. Murphy. Discusses the results of tests of this windmill, from a mathematical standpoint. 2500 w. Kansas Univ Quar—Oct., 1897. No. 17137 D.

SHOP AND FOUNDRY.

Bearings.

Babbiting and Fitting Bearings. All the babbitted surfaces met with in an ordinary engine are discussed and illustrated, with instructions. 2500 w. Power—Dec., 1897. No. 17202.

Belt Transmission.

The Transmission of Power by Belts and Pulleys. C. L. Redfield. Discusses the causes of waste of power in belt transmission and shows how choice of proper sizes of pulleys, and belt speeds, together with judicious opposing of strains, will enable large economies to be effected. 4500 w. Engineering Magazine—Jan., 1898. No. 17400 B.

Cost Keeping.

Cost Keeping Methods in Machine Shop and Foundry. Henry Roland. Devoted to problems of general expense and the determination of selling prices, showing the methods of leading American shops. 3500 w. Engineering Magazine—Jan., 1898. No. 17398 B.

Method of Keeping Weekly Shop Costs. W. N. Moore. Gives a plan of recording labor and material costs which has been in use for some years and found to be accurate, direct, and inexpensive. 1300 w. Ry & Engng Rev—Dec. 18, 1897. No. 17238.

Drop Hammer.

The Largest Drop Hammer in the World. Illustrated description of what is probably the largest specimen of this type of tool in existence, made for and by the Billings & Spencer Company, of Hartford, Conn. 1800 w. Ir Age—Dec. 30, 1897. No. 17469.

Flanges.

The Attachment of Flanges to Pipes. (Befestigung von Flanschen an Leitungsröhren.) Describing a form of roller expanding tool for securing flanges to copper steam pipes. 1000 w. Zeitschr d Ver Deutscher Ing—Nov. 13, 1897. No. 17328 D.

Gear Cutting.

The Fellows Gear Shaper. Illustrated description of a new machine and a new system for cutting gears. 2800 w. Am Mach—Dec. 9, 1897. No. 17054.

Grinding.

A Rational Construction of Mill with Metallic Grinding Surfaces. (Sur la Construction des Moulins à Meules Métalliques.) The mill constructed by M. Schweitzer, has channeled grinding surfaces revolving in a horizontal plane, similar to burr millstones, and is claimed to be superior to the roller mill. 600 w. Comptes Rendus—Nov. 29, 1897. No. 17321 D.

Hoisting Machinery.

See Elecrical Engineering, Power.

Ingot Mold.

A New Form of Ingot Mold for Casting Brass or Bronze Ingots, with Remarks on the General Form of Ingots. Erwin S. Sperry. Illustrated description. 1700 w. Trans Am Inst of Min Engs—Nov., 1897. No. 16961 D.

Loom.

The Joubert Loom and Warp Beam. (Le Métier Mécanique et l'Ourdissoir, Système Joubert.) The improved Joubert loom, for weaving ribbons, velvets and other fine fabrics is able by reason of its positive movements, and mechanical perfection to produce the highest grade of work at a rate of 40 to 50 per cent. faster than ordinary looms, and is coming into extensive use in Lyons. 2500 w. 1 plate. La Revue Technique—Nov. 25, 1897. No. 17309 D.

Lubrication.

On the Theory of Lubrication and the Determination of the Thickness of the Film of Oil in Journal Bearings. F. L. O. Wadsworth. Brief review of a paper on this subject by Prof. Osborne Reynolds, published in the *Transactions of the Royal Society*, with additional notes from experiments and study by the writer. Ill. 5500 w. Jour Fr Inst—Dec., 1897. Serial. 1st part. No. 17095 D.

Practical Experience in the Use of Lubricants. (Erfahrungen über die Praktische Verwendung der Schmiermitttel in der Technik.) Dr. Koller. Discussing the effects of temperature, composition and conditions of use upon the effective lubrication. 2500 w. Glaser's Annalen—Nov. 15, 1897. No. 17353 D.

Machine Tools.

Machine Tools in the Future. A tool-maker discusses the attitude of buyer to seller in England, making suggestions and aiming to influence buyers to depend on home manufacture. 1500 w. Engr, Lond—Dec. 17, 1897. No. 17421 A.

Pig Iron.

Scrap Carrying and Pig Iron Values. Translation of a paper by Dr. Wuest, read at meeting of German Foundrymen's Assn. Shows the present status of German foundry knowledge. 2000 w. Ir Trd Rev—Dec. 2, 1897. Serial. 1st part. No. 16981.

Pistons.

A Piston Pattern. G. H. Willard. Describes and illustrates a quick and cheap pattern and a successful way of molding. 400 w. Am Mach—Dec. 16, 1897. No. 17162.

Projectiles.

See same title under Mining and Metallurgy, Iron and Steel.

Rock Drills.

See Mining and Metallurgy, Mining.

Shop Driving.

See Electrical Engineering, Power.

Slide Rule.

The Slide Rule. A. H. Eldridge. How to make and use a slide rule. 1400 w. Mach, N. Y.—Dec., 1897. No. 17032.

Speed Indicator.

The Paragon Ball-Bearing Speed Indicator. Illustrated description of a device for counting the revolutions of anything the end of which is accessible, usually a shaft or spindle. 800 w. Am Mach—Dec. 2, 1897. No. 16984.

Steel Casting.

See same title under Mining and Metallurgy, Iron and Steel.

Time-Saving.

Time-Saving and Its Relation to Profits. Henry Hess. An analysis of methods for reducing costs, with consideration of an example under each method, and diagrams. 4200 w. Am Mach—Dec. 16, 1897. No. 17161.

Twist Drills.

Teachings of a Drill Factory. John Randol. Describes the manufacture of twist drills as carried on by the T. & B. Tool Co., of Danbury, Conn. Photographs of various steps of the process are given, and description of the fine work. 2800 w. Am Mach—Dec. 23, 1897. Serial. 1st part. No. 17274.

MISCELLANY.

Aerodynamics.

Gliding Experiments. Octave Chanute. A study of the laws underlying the possible solution of the problem of flight, with account of recent experiments and general information. Ill. 10500 w. Jour W Soc of Engs—Oct., 1897. No. 17086 D.

Artillery Mountings.

New Mountings for Coast Artillery. Abstract of a paper contributed by Sir George Clarke to the "Proceedings of the Royal Artillery Institution," describing new mountings devised to give speed. Ill. 2800 w. Engr, Lond—Dec. 17, 1897. No. 17420 A.

Automobiles.

A Year's Progress in Motor Road Vehicles in Great Britain. A general survey of the results with description of some of the more noticeable productions, and systems introduced. Ill. 7000 w. Ind & Ir—Dec. 3, 1897. No. 17151 A.

Radius of Action of Electric Motor Carriages. Hiram Percy Maxim, in *The Horseless Age*. An account of a satisfactory trip in a Columbia carriage of the Pope Manufacturing Company. 2400 w. Sci Am Sup—Dec. 11, 1897. No. 17065.

Road Motors in France. Editorial on the experiments made in France with the Scotte system of road traction, which is in effect a tramway without rails, with interesting features of the system. It has been working a year and seems to have proved its suitability for use under certain conditions. 2300 w. Engng—Nov. 26, 1897. No. 17007 A.

Self-Propelled Road Vehicles, 1896-97. W. Worby Beaumont. A paper read before the Liverpool Section of the Self-Propelled Traffic Assn. Reviews what has been accomplished in this field during the last year, especially in regard to heavy traffic, giving a list of British vehicles that have been brought out, with comments. 3500 w. Ind & Ir—Dec. 3, 1897. No. 17150 A.

The Competition of the Heavy-Weight Vehicles. (Concours des Poids Lourds.) The official report of the commission of the Automobile Club of France, with illustrations of the various vehicles, tables of weights, map and profile of the road, and full details of the performance of each automobile. Two artleles, 20,000 w. 1 plate. Le Génie Civil—Nov. 20, 27, 1897. No 17303 G.

Twelve Months Continental Progress in Motor Road Vehicles. Brief review of progress giving the first place to France and merely mentioning work in Germany, Belgium and Italy. 1200 w. Ind & Ir—Dec. 3, 1897. No. 17152 A.

Bicycles.

A New Cycle Brake. Illustrated description of a brake that may be applied almost instantaneously without relaxing the grip. The invention of Horatio Phillips. 800 w. Engng—Nov. 26, 1897. No. 17014 A.

Some Lessons of the Stanley Show. Joseph Horner. Comments on the exhibits of machinery for bicycle-making being confined to American firms and discusses the reasons. 3000 w. Engng—Dec. 3, 1897. No. 17118 A.

The American Bicycle: Its Theory and Practice of Coutruction. Leonard Waldo. An interesting consideration of bicycle manufacture, especially the question of chain *versus* chainless driving. Discussion follows. 6000 w. Jour Soc of Arts—Dec. 3, 1897. No. 17096 A.

The Stanley Cycle Show. Comments on the features of the machines shown, and on points needing attention in the design of bicycles and in their use. 3000 w. Engng—Nov. 26, 1897. No. 17011 A.

Buckling.

Resistance to Buckling, in Theory, Experiment and Practice. (Die Knickfestigkeit in Theorie, Versuch und Praxis.) F. von Emperger. A mathematical investigation, comparing the various theories, and plotting the corresponding curves. Serial. Part 1. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 3, 1897. No. 17342 B.

Cableway.

A Cableway Over Chilkoot Pass. Details of this work furnished by the Trenton Iron Co., of Trenton, N. J. 700 w. R R Gaz—Dec. 24, 1897. No. 17412.

Circulation.

The Circulation of Steam in Pipes. (Circulation de la Vapeur dans les Tuyaux.) A paper by M. Horsin-Déon, showing that vapors circulating in pipes do not readily mingle, but flow in layers or concentric masses. 1200 w. Moniteur Industriel—Nov. 20, 1897. No. 17391 F.

Cylindrical Bales.

A Machine for Making Cylindrical Bales. Illustrated description explaining the theory and construction of the press and its operation. 1500 w. Eng News—Dec. 16, 1897. No. 17177.

Flow.

Determination of the Velocity of Water in Pipes. (Bestimmung der Wassergeschwindigkeit in Druckleitungen.) A mathematical discussion showing the backward reaction upon the pipe and enabling the strength of anchorage to be computed. 1500 w. Schweizerische Bauzeitung—Oct. 30, 1897. No. 17365 B.

Great Gun.

A Great Coast-Defence Gun. G. L. Carden. Illustrated account of the largest gun ever constructed in the United States, now being made at the Bethlehem Iron Works. 3000 w. Harper's Wk—Dec. 11, 1897. No. 17063.

Ladders.

Tests of Ladders. George D. Rice. Illustrated account of tests recently made by writer, with testing machine used. 700 w. Eng & Min Jour—Dec. 25, 1897. No. 17295.

Matter.

The Manner of Changes in Matter. (Das Wesen Stofflicher Veränderungen.) An address by Prof. Klaudy, dealing with the molecular theories, and the relation of chemical, thermal and mechanical forces in the transformations of matter. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 10, 1897. No. 17343 B.

Motocycles.

Motocycles. For the purpose of developing a discussion on this subject a letter enclosing questions relating to the sübject was sent out, and the results are given. Ill. 12500 w. Jour W Soc of Engs—Oct., 1897. No. 17083 D.

Paper Testing.

Normal Paper (Normal Papiere.) Tabulated data and results of tests of paper made by Prof. Herzberg at the Royal Testing Laboratory at Berlin. 10000 w. Mitt aus d Kgl Tech Versuchanstalt—Part V. 1897. No. 17378 F.

Radiation.

A Photographic Method of Recording Emissions of Heat. (Sur un Mode d'Enregistrement Photographique des Effluves Thermiques.) A memorandum by M. Guébhard. presented to the French Academy by M. Lippmann. By the use of a bath of diamido-phénol the heat radiation may be photographed in a manner similar to magnetic lines of force with iron filings. 1000 w. Comptes Rendus—Nov. 22, 1897. No. 17318 D.

Rope Tests.

The Influence of Length on Tests of Hemp Rope. (Ueber den Einfluss der Versuchslänge auf die Festigskeit von Haufseilen.) A paper by Prof. Rudeloff showing that the results depend upon the length of the test specimen, and to be comparable the specimens should be of equal length. 15000 w. Mitt aus d Kgl Tech Versuchsanstalt—Part V. 1897. No. 17379 F.

Stability.

Theory of the Stability of Locomotives. (Théorie de la Stabilité des Locomotives.) M. J. Nadal. A mathematical and geometrical analysis of the various movements of a locomotive engine considered as affecting the stability of the whole. 10000 w. Ann des Ponts et Chaussées—Part III. 1897. No. 17345 F + G.

Testing.

Experience with a New Machine for Testing Materials by Impact. S. Bent Russell. Defines resilience and studies its measurement, and modern methods of determining its value. Gives illustrated description of impact machine devised by the writer, and tests made with it, giving results and conclusions, 6300 w. Pro Am Soc of Civ Engs—Dec. 1, 1897. No. 17443 F.

Thermodynamics.

The Theta-Phi Diagram. Henry A. Golding. The theta-phi diagram shows, by its area, the proportion of heat utilized to the heat received. Comparison is made with the indicator diagram. 900 w. Prac Eng—Dec. 3, 1897. No. 17128 A.

The Variation of Energy in Isothermal Transformations. (De la Variation de l'Energie dans les Transformations Isothermes.) A mathematical investigation by M. Pellat presented to the French Academy by M. Lippmann, giving particular applications of the general formula of Clapeyron. 1200 w. Comptes Rendus—Nov. 8, 1897. No. 17316 D.

MINING AND METALLURGY.

COAL AND COKE.

American Coals.

The Calorific Value of American Coals. William Kent. A discussion of the paper of H. W. Lord and F. Haas, read at the Chicago meeting, Feb., 1897. 4400 w. Trans Am Inst of Min Engs—Nov., 1897. No. 16960 D.

Anthracite.

The Heat-Value of Anthracite Small Sizes, and the Best Methods of Burning Them. Albert C. Leiseuring. Read at a meeting of the Anthracite Coal Operators' Assn., New York. Practice favors an under-grate forced blast, usually by fan or steam jet. A large grate area is essential. 1200 w. Col Guard—Nov. 26, 1897. No. 17024 A.

British Coal.

The British Coal and Coke Industries for 1897. A review of the output, exports, prices and conditions for 1897. 3500 w. Ir & Coal Trds Rev—Dec. 17, 1897. No. 17459 A.

Coal Cutting.

Electric Coal-Cutting Machinery. (Schlitz-und Schrämmaschine mit Elektrischem Antriebe.) Schaub's electric coal cutter consists of a number of parallel boring tools driven by chain connection to electric motors. 2500 w. 1 plate. Oesterr Zeitschr f Berg-u Hüttenwesen—Dec. 11, 1897. No. 17376 B.

Mechanical Appliances for the Getting of Coal. Ernest Kilburn Scott. The first of a series of articles which will describe and illustrate the more important coal-cutting machines in use in England and other countries. 1500 w. Ir & Coal Trds Rev—Dec. 10, 1897. Serial. 1st part. No. 17207 A.

Coal Getting.

Coal Getting without Blasting. Edwin Cottam. Read before the South Wales Institute of Engineers. A description of the construction and method of working of a machine which the writer calls the "up wedge" intended for wedging down coal, shale or soft stratified rock. Ill. 1800. Ir & Coal Trds Rev—Dec. 10, 1897. No. 17208 A.

Coal Industry.

Technical Progress of the Coal Industry in 1897. Considers the improvements in explosives, shipment, lighting, mining work, shaft sinking, &c. 5500 w. Ir & Coal Trds Rev—Dec. 17, 1897. No. 17456 A.

Coal Supply.

The Coal Supply of the United Kingdom. Leonard H. Courtney. Substance of presidential address before the Royal Statistical Society. Tracing from facts of recent experience, confirmation of the anticipations of Jevons as published in his book, *The Coal Question*, thirty years ago. 3300 w. Col Guard—Dec. 17, 1897. No. 17416 A.

Coke Manufacture.

Possible Economies in the Manufacture of Coke. Editorial urging the adoption of by-product coke ovens in England, and showing their economy. 1700 w. Ir & Coal Trds Rev—Nov. 19, 1897. No. 16931 A.

Coking.

Coking on a Bee-Hive Oven. William B. Phillips. Reports personal observations of the progressive changes that take place in a bee-hive oven from the moment of charging the coal to the withdrawal of the coke. 1400 w. Eng & Min Jour—Dec. 18, 1897. Serial. 1st part. No. 17183.

Disturbances.

Some Local Disturbances in Anthracite Collieries. Hobt. Huxham. Read before the South Wales Inst. of Engineers. Instances of disturbances arising from the folding of the strata and the difficulties contended with. 3000 w. Col Guard—Dec. 10, 1897. No. 17233 A.

East Durham, Eng.

The East Durham Coalfield. From the *Newcastle Chronicle*. Report of the condition of the coal trade in this district, which has seriously felt the recent depression. 1400 w. Col Guard—Nov. 19, 1897. No. 16920 A.

Screening.

The Development of Screening Apparatus. G. Schwidtal. From a communication to *Glückauf*. Illustrated description of the advances made, and explanation of the causes that led to them. 600 w. Col Guard—Nov. 26, 1897. No. 17022 A.

Syndicate.

A Collier's Syndicate. History of the Associated Colliers of Rive-de-Gier. The attempt resulted in failure but is of interest especially at the present time. Condensed from account in *Annales des Mines*. 2800 w. Col Guard—Dec. 10, 1897. No. 17232 A.

COPPER.

Copper Assay.

The Electrolytic Assay as Applied to Refined Copper. Discussion of paper of George L. Heath read at Lake Superior meeting, July, 1897. 3500. Trans Am Inst of Min Engs—Nov., 1897. No. 16959 D.

GOLD AND SILVER.

Ararat.

Neglected Goldfields. William Bradford. Part first gives some information of the Ararat goldfield in Australia. 800 w. Aust Min Stand—Nov. 4, 1897. Serial. 1st part. No. 17129 B.

Auriferous Lodes.

The Genesis of Certain Auriferous Lodes. John R. Don. A valuable condensed paper, giving original work, with tabulated results. Ill. 25000 w. Trans Am Inst of Min Engs—Nov., 1897. No. 16962 D.

California.

A "Pocket" Horizon in Trinity County, California. Oscar H. Hershey. Describes the geology of this region and the conditions governing the distribution of the gold "pockets." 1600 w. Min & Sci Pr—Dec. 11, 1897. No. 17179.

Chlorination.

The Modern Gold Chlorination Process for the Treatment of Gold Ores. John E. Rothwell. Illustrated description of the barrel chlorination process and its application. 11000 w. Min & Sci Pr—Dec. 18, 1897. No. 7297.

Cyanid Process.

The Cyanid Process for Gold Ores in Western America. Thomas Tonge. Reviewing the development of the process in America, and showing the importance of testing the ores with proper skill before assuming the process to be suitable. The necessity of skilled supervision is also emphasized. 3500 w. Engineering Magazine—Jan., 1898. No. 17401 B.

The Treatment of Slimes in the Transvaal. (Traitement des Slimes au Transvaal.) A review by M. Schiff, of J. R. Williams' paper on the electrical treatment of cyanid slimes by the Siemens and Halske method. 3000 w. Le Génie Civil—Nov. 13, 1897. No. 17302 D.

Dredge.

A New Form of Dredge for River-Bed Placers. J. M. Sweeney. Describes a proposed method for cleaning up the bedrock of streams containing gold deposits which claims to overcome the objections to known methods, and can also be used for any deposit of gravel or sand. Ill. 1600 w. Eng & Min Jour—Dec. 25, 1897. No. 17293.

Gold Production.

The Production of Gold Since 1850. Edward Sherwood Meade. A discussion of this subject aiming to explain why an increase in value of this commodity is not accompanied by an increasing production. Reviews improvements in mining, considers the future of gold, and its production in various countries. Also appendix. 8000 w. Jour Pol Econ—Dec., 1897. No. 17288 F.

Klondike.

The Latest News from the Klondike-Yukon Country. John D. McGillivray, in the *New York Herald*. Extracts from letters sent from this region reporting the hard conditions of labor, and the doubtful prospects. 2000 w. Eng & Min Jour—Dec. 11, 1897. No. 17102.

The Relief of the Klondike. Perry F. Nursey. Reviews the situation in this district, and explains the works intended to be undertaken by the North-western Trust and Development Company of America. 1700 w. Ind & Ir—Nov. 19, 1897. No. 16911 A.

Ontario.

An Epidemic of Mismanagement. Horace V. Winchell. A discussion of the mistakes made in the management of the Rainy River district in western Ontario. 1600 w. Can Min Rev—Nov., 1897. No. 17033 B.

The Michipicoton Mining District in Ontario. Wilson B. Cue. History of the discovery of this field, with description of the region, and general information. 2000 w. Eng & Min Jour—Dec. 25, 1897. No. 17296.

Placer Mining.

Placer Mining on Wheels. J. M. Sweeney. Illustrated description of a machine to recover gold from placer beds by washing all the gravel. 1800 w. Ry & Engng Rev—Dec. 18, 1897. No. 17241.

Placers.

A Mountain Placer. Arthur Lakes. Description of a placer located high in the mountains of Colorado, near Breckenridge. Discusses the points to be considered in making an estimate of a placer's value, the natural features that bear on its value, and veins sometimes discovered in working a placer. Ill. 2000 w. Mines & Min—Dec., 1897. No. 17169 C.

Prospecting.

Border Prospecting. Stanley Hunter. Report to the Victorian Secretary for Mines, upon the work done on the Victorian side of the frontier in prospecting the border country between Cape Howe and Forest Hill. 2800 w. Aust Min Stand—Nov. 4, 1897. No. 17130 B.

Smelting.

Matte Smelting at the Hall Mines, British Columbia. Robert R. Hedley. Brief illustrated description of what is probably the largest furnace of its kind. 500 w. Eng & Min Jour—Dec. 11, 1897. No. 17101.

Statistics.

Gold and Silver (Gold und Silber.) A review of the relative production of gold and silver from 1871 to 1897, with charts of production by years and countries. 2000 w. Two plates. Glückauf—Dec. 11, 1897. No. 17372 B.

Utah.

The Highland Bay Mine and Mill, Bingham, Utah. Describes this mine which yields two distinct ore bodies, one carrying gold and silver, the other copper, gold and silver. Also illustrated description of mill. 1700 w. Eng & Min Jour—Dec. 4, 1897. No. 17037.

IRON AND STEEL.

Apollo Works.

The Apollo Iron and Steel Company's Works at Vandergrift. Franklin Hilton. Illustrated detailed description of a plant in the United States, for the production of sheets. 2000 w. Ir & Coal Trds Rev—Dec. 3, 1897. No. 17123 A.

Armor.

British, French and German Armor. A comparison of thick armor recently tested. Ill. 1900 w. Engr, Lond—Nov. 19, 1897. No. 16916 A.

The Armor Plate Question. A summary of American armor-plate history down to the present time. 5000 w. Bul Am Ir & Steel Assn—Dec. 20, 1897. No. 17182.

The Armor Plate Report. A full abstract of the report presented to the Secretary of the United States Navy, by the Naval Armor Factory Board. 7500 w. Ir Age—Dec. 9, 1897. No. 17056.

Blast Furnaces.

Increasing Blast Furnace Capacity. Tabulated information of the blast furnaces of the United States, with editorial. Shows the number of furnaces to have decreased greatly, while the weekly capacity has increased. 2000 w. Am Mfr & Ir Wld—Dec. 10, 1897. No. 17105.

Notes on Six Months Working of Dover Furnace, Canal Dover, Ohio. Arnold K. Reese. A statement of unusual results obtained during a period of six consecutive months, giving conditions and figures. Ill. 1800 w. Trans Am Inst of Min Engs—Nov., 1897. No. 16958 D.

Chicago.

The Chicago Iron Trade in 1897. George W. Cope. A review of the leading features of the trade, tracing the improvement by months, and giving statistics of pig iron, finished iron and steel, rails, &c. 4500 w. Ir Age—Dec. 30, 1897. No. 17470.

Forgings.

Steel Forgings. A discussion held Oct. 6, 1897, in connection with the Society's visit to the Bethlehem Iron Works, in its "Excursion to the East" in September, 1897. 4000 w. Jour W Soc of Engs—Oct., 1897. No. 17085 D.

Great Britain.

The British Iron and Steel Industries in 1897. General review of the condition of these industries, giving the furnaces in blast, exports, wages, &c. 3000 w. Ir & Coal Trds Rev—Dec. 17, 1897. No. 17460 A.

Iron Ore.

The Iron-Ore Supply. John Birkinbine. Interesting review of statistics of production in the United States and other countries. 3300 w. Trans Am Inst of Min Engs—Nov., 1897. No. 16952 D.

Ironworks.

Davey, Paxman and Company's Works, Colchester. Illustrated account of these noted works, noticing special features observed on a recent visit. 2000 w. Engr, Lond—Dec. 10, 1897. Serial. 1st part. No. 17230 A.

Japan.

Japan as a Producer of Iron. Irvin McDowell. The scheme of Japan for making her own iron, steel and rails is discussed, with some of the difficulties she must overcome. 1000 w. Ir Trd Rev—Dec. 2, 1897. No. 16980.

Magnetic Ore.

The Preparation of Phosphoretted Magnetite at Lulea, Sweden. (Die Aufbereitung Phosphorreicher Magnetite in Lulea.) The magnetic ore is separated from the apatite after crushing, by means of electro-magnetic separators. 1200 w. Zeitschr d Ver Deutscher Ing—Nov. 13, 1897. No. 17327 D.

Marquette Range.

The Marquette Range.—Its Discovery, Development and Resources. James E. Jopling. Interesting history of this valuable iron-range. Ill. 4000 w. Trans Am Inst of Min Engs—Nov., 1897. No. 16956 D.

Mesabi Range.

Explorations in the Mesabi Range. E. J. Longyear. The mode of occurrence and methods of work are explained. 2000 w. Trans Am Inst of Min Engs—Nov., 1897. No. 16953 D.

Mining Methods on the Mesabi Range. C. E. Bailey. A résumé of methods of mining in this region. The ore is a soft hematite, and the two systems of operating are the stripping or open pit, and the underground system. 3000 w. Trans Am Inst of Min Engs—Nov., 1897. No. 16957 D.

Philadelphia.

The Philadelphia Iron Market. Thomas Hobson. A review of the year 1897, with tabulated statements, and general information. 2500 w. Ir Age—Dec. 30, 1897. No. 17471.

Pig Iron.

See Mechanical Engineering, Shop and Foundry.

Pittsburg,

The Pittsburg Iron Trade in 1897. Robert A. Walker. A summary of the trade for the year, the special features, and review of different classes of work. 6500 w. Ir Age—Dec. 30, 1897. No. 17473.

Projectiles.

American Armor-Piercing Projectiles. Drawings of some of the latest designs of projectiles for which contracts have been recently awarded by the United States with official particulars of the requirements and tests specified. 2000 w. Engr, Lond—Nov. 19, 1897. No. 16917 A.

Steel Casting.

Steel Casting in Vacuum. A description of the Ellis-May process, with drawings and details; also a consideration of the practical results that must follow. 4500 w. Ir & St Trds Jour—Dec. 4, 1897. No. 17237 A.

Steel Works.

The Braeburn Steel Works. An account of the organization and opening of new works near Pittsburgh, with description and plan. 1300 w. R R Gaz—Dec. 3, 1897. No. 16969.

The Maryland Steel Company. Illustrated detailed description of the interesting plant at Sparrow's Point, Md. 2800 w. Ir Age—Dec. 9, 1897. No. 17055.

The Steel Works of the Glasgow Iron and Steel Company. Illustrated detailed description of one of the largest and best known concerns of its kind in Scotland. 3500 w. Ir & Coal Trds Rev—Nov. 19, 1897. No. 16930 A.

Stress.

Thermal Condition of Iron and Steel under Stress, and Measurement of Stress by Means of Thermo-Electricity. C. A. P. Turner. A discussion of the method of determining the stress in metal by measurement of the heat gained or lost when the stress is applied. 4800 w. Pro Engs' Soc of W Penna—Sept., 1897. No. 17442 F.

Wrought Iron.

Experiments on Melting Wrought Iron. K. K. An account of experiments made to find a cheaper method than the use of the Nobel furnace. 1800 w. Am Mach—Dec. 23, 1897. No. 7276.

MINING.

Blasting.

Electric Blasting. William Maurice. Abstract of paper read at meeting of the Chesterfield and Midland Counties Inst. of Engineers, Nottingham, Eng. Discusses low and high tension fuses, selection of igniters and detonators. 1800 w. Ir & Coal Trds Rev—Dec. 17, 1897. No. 17458 A.

Experiments with 'Oxy-Hydrogen for Mine Blasting. From a communication by Bergassessor Heise to *Glückauf*. Describes experiments with cartridges containing a compressed mixture of oxygen and hydrogen, which are ignited by an electric spark. 1100 w. Col Guard—Dec. 10, 1897. No. 17234 A.

Centrifugal Fan.

The Theory of the Centrifugal Pump and Fan. C. H. Innes. Read before the North-East coast Inst. of Engineers and Shipbuilders. Discussion of this theory and the proper design of such pumps and fans. 2800 w. Col Guard—Dec. 10, 1897. Serial. 1st part. No. 17236 A.

Electric Hauling.

See Electrical Engineering, Power.

Fire Damp.

Explosives and Firedamp in England. (Les Explosifs et le Grisou en Angleterre.) A review of the experiments made by the English committee on flamelesss explosives, with illustrations of the testing plant at Hebburn, England. 4000 w. Le Génie Civil—Nov. 13, 1897. No. 17300 D.

The Walcher "Pneumatophor." (Der von Walchersche "Pneumatophor.") An apparatus for enabling explorations to be made in mines containing irrespirable gases. The same air is used again and again, the carbonic acid being absorbed by caustic soda, and fresh oxygen supplied. 5000 w. Glückauf—Dec. 4, 1897. No. 17371 B.

Improvements.

Improvements in Mine Plant, Westphalia. M. Robiaud. From a communication to the Société de l'Industrie Minérale, Saint-Etienne. Observations on ropes and winding engines, with illustrations. 3800 w. Col Guard—Dec. 3, 1897. No. 17156 A.

Improvements in Mining and Metallurgical Appliances during the Last Decade. E. Gybbon Spilsbury. Reviews the many and various improvements made in the last ten or twelve years which have resulted in increase of out-put and lessening of cost. 5500 w. Trans Am Inst of Min Engs—Nov., 1897. No. 16951 D.

Mine Titles.

Acquisition of Mines by Adverse Possession. An explanation of English law relating to titles of mines or quarries. 2700 w. Col Guard—Dec. 17, 1897. No. 17415 A.

Mining Laws.

The Proposed Revision of the Mining Laws. Full text of the report of the sub-committee of the International Gold Mining Convention at Denver. 3500 w. Eng & Min Jour—Dec. 4, 1897. No. 17038.

Regulation Act.

Queensland Mines Regulation. A summary of some of the recommendations made by the Royal Commission, appointed to report on the laws relating to mining for gold and other minerals. 1200 w. Col Guard—Dec. 3, 1897. No. 17154 A.

Review.

Review of Recent Progress in the Mining Industry. (Revue des Progrès de l'Industrie Minière.) M. Leproux. Especially devoted to recent improvements in machinery and methods in all parts of the world, with many illustrations. 10000 w. Bulletin de la Société d'Encour—Nov., 1897. No. 17348 F + G.

Rock Drills.

The Plant and Product of the Ingersoll-Sergeant Drill Co. Charles W. Melcher. History of the company and description of the plant and the class of machinery manufactured by them. Ill. 3000 w. Jour W Soc of Engs—Oct., 1897. No. 17084 D.

Safety Lamp.

Laune Re-lighting Safety Lamp. From a report by M. G. Chesneau, to the French Fire-damp Commission, published in the *Annales des Mines*. Illustrated description, with report of trials, and the advantages and disadvantages. 1200 w. Col Guard—Nov. 19, 1897. No. 16923 A.

The First Safety Lamps. William Clifford. Sequel to an article that appeared in this paper in Jan., 1897. The Davy lamp and some of the improvements which have been attempted upon it. 3500 w. Mines & Min—Dec., 1897. No. 17172 C.

Salt Mining.

The Extension of the Wolfdietrich Tunnel. (Die Erweiterung des Wolfdietrichstollens.) Describing the work upon a deep tunnel in the Salzburg salt mines. Electric machinery driven by hydraulic power was used, including the Siemens' rock drill. 6000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 13, 1897. No. 17374 B.

Steam Power.

Economizing Steam Power at Mines. From an abstract for the Societé de l'Industrie Minérale, of a report, published in the *Zeitschrift für das Berg-Hütten und Salinenwesen*, by R. Zörner, on the saving he effected in the power required for working the Royal König collieries, near Neunkeirchen. 2300 w. Col Guard—Nov. 26, 1897. No. 17021 A.

Surveys.

Mine Maps and Surveys. Selwyn M. Taylor. Abstract of paper read before the Western Pennsylvania Central Mining Institute. Briefly describes how a mine survey should be made. 600 w. Am Mfr & Ir Wld—Dec. 24, 1897. No. 17436.

Transportation.

Notes on Mining and Transportation. Harry J. Lewis. Read before the Western Pennsylvania Central Mining Institute. Showing how closely allied are these two industries. 1500 w. Am Mfr & Ir Wld—Dec. 24, 1897. No. 17435.

U. S. Mining Law.

The Proposed Revision of the United States Mining Law. R. W. R. Editorial criticism of the resolutions presented by W. S. Keyes, and the propositions of Mr. Freeland. 1800 w. Eng & Min Jour—Dec. 11, 1897. No. 17100.

MISCELLANY.

Carbides.

A New Method of Preparing Carbides. (Nouvelle Méthode de Préparation des Carbures.) A paper by M. Moissan before the French Academy upon the preparation of metallic carbides by the action of carbide of calcium upon the corresponding oxides. 1500 w. Comptes Rendus—Nov. 29, 1897. No. 17320 D.

Diamond Fields.

The Development of the South African Diamond Fields. H. S. Canby. A study of the development of these mines. Part first deals principally with the alluvial or placer mines and dry diggings, giving interesting information, 2500 w. Yale Sci M—Nov., 1897. Serial. 1st part. No. 16933 C.

Graphite.

Graphite in Siberia. R. Helmhacker. Information of the discovery and working of these valuable deposits of graphite, which rank among the richest and most promising in the world. 1500 w. Eng & Min Jour—Dec. 25, 1897. No. 17294.

Mica.

Mica—Its Uses and Appliances. Treats of the peculiarities of this mineral and its general uses. 1300 w. Can Min Rev.—Nov., 1897. No. 17034 B.

Petroleum.

The Development of the Russian Petroleum Industry. (Die Entwicklung der Erdöl Industrie in Russland.) A general review of the past 30 years with commercial statistics from official reports. Three articles. 7500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 27, Dec. 4, 11, 1897. No. 17375 G.

Phosphates.

The Phosphate Mines of South Carolina. George Leighton. A description of the peculiar deposits and the methods of mining, with a history of their discovery; the nature of the rock, its appearance, and some of the theories in regard to the animal life from which it was originally formed. 3500 w. Mines & Min—Dec., 1897. No. 17171 C.

Sweden.

The Mining and Metallurgical Industries of Sweden as Shown at the Stockholm Exhibition. Bennett H. Brough. Interesting account with excellent description of exhibits in the departments named. Also discussion. Ill. 10,000 w. Jour Soc of Arts—Dec. 10, 1897. No. 17190 A.

Testing.

Metallography as a Testing Method. F. Osmond. Enumerates methods for distinguishing the components. 1800 w. Am Mfr & Ir Wld—Dec. 3, 1897. Serial. 1st part. No. 17036.

Tin.

Chinese Tin Smelting. Frank Owen. Extract from a paper on "Mining in Perak," read before the Inst. of Mining and Metallurgy, London. Describes their system as carried out in a blast furnace. 1400 w. Col Guard—Nov. 19, 1897. No. 16921 A.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Acetylene. Vivian B. Lewes. Abstract of a lecture delivered at the London Institution. Reviews the history of the commercial formation of calcic carbid, describes the process of manufacture, the apparatus for generating acetylene and the difficulties in its utilization. 2800 w. Jour of Gas Lgt—Nov. 30, 1897. No. 17061 A.

The Technical Analysis of Calcium Carbid and Acetylene and the Purifying of the Latter. G. Lunge and Edward Cedercreutz. From the *Zeitschrift für Angewandte Chemie*. Gives the method proposed by the authors to determine analytically, the possible 4 per cent. of impurities in acetylene. 2000 w. Pro Age—Dec. 15, 1897. No. 17168.

Use of Acetylene for Enriching Gas Produced from Lean Coals. Th. Vautier. Presented at the convention of the "Société Technique de de l'Industrie du Gaz." Describes a series of tests upon coals which produce a gas having a yield of less than 3.6 cubic feet per carcel hour, or .5 cubic feet per candle hour. 3300 w. Pro Age—Dec. 1, 1897. No. 16946.

Ammonia.

Sulphate of Ammonia. E. A. Harman. Read before the Manchester District Institution of Gas Engineers. The various methods for the disposal of ammoniacal liquor are reviewed, with methods and systems adopted for making use of waste gases and recovering other by-products. Discussion follows. Ill. 5200 w. Jour Gas Lgt—Nov. 30, 1897. No. 17059 A.

Coal Gas.

On a Coal Gas Element. Dr. W. Borchers. Read before the Verb. Deutsch. Electrotechniker. A description of the investigations made and apparatus used. Ill. 1600 w. Elec Eng, N. Y.—Dec. 23, 1897. No. 17262.

Some Recently Discovered Constituents of Coal Gas. Discusses the views of Berthelot and of P. Fritzeche, and the limited study that has been given the subject. 1200 w. Jour Gas Lgt—Dec. 7, 1897. No. 17218 A.

Distribution.

Mr. D. Coats Niven on Gas Distribution. J. Skinner. A criticism of views advanced by Mr. Niven. 1600 w. Jour of Gas Lgt—Dec. 7, 1897. No. 17219 A.

Fires.

Gas as a Cause of Fires. Facts taken from a paper by A. Müller, published in the *Journal für Gasbeleuchtung*, proving gas one of the safest illuminants. 900 w. Jour of Gas Lgt—Nov. 30, 1897. No. 17057 A.

Florida.

Some Random Notes on Florida Gas Works. A few notes concerning the plants and their operation. 1900 w. Am Gas Lgt Jour—Dec. 13, 1897. No. 17097.

Gas Bills.

X-Rays on the Gas Bill. An explanation of the method of meter reading and making of charges, with the aim of removing the distrust and misunderstanding of the general public. 3300 w. Am Gas Lgt Jour—Dec. 6, 1897. No. 17035.

Gas Composimeter.

Principle of the Gas Composimeter. Edward A. Uehling, in the *Stevens Indicator* The apparatus is based on the laws governing the flow of gas through small apertures. Explains the means of fulfilling the necessary conditions, and gives autographic records taken. Ill. 2200 w. Pro Age—Dec. 1, 1897. No. 16947.

Gas Stoves.

The Determination of the Efficiency and Loss of Heat in Gas-Stoves. Abstract translation of article by F. Haber, in *Journal für Gasbeleuchtung*. Gives a method for the estimation of the duty of a gas stove, much more simple than the methods in general use. 2000 w. Jour Gas Lgt—Dec. 14, 1897. No. 17272 A.

Gas Works.

The Proposed new Site for the Edinburg and Leith Gas-Works. Reports of W. R. Herring and G. Livesey. 2500 w. Jour of Gas Lgt—Dec. 14. 1897. No. 17273 A.

Hydraulic Mains.

The Work of the Hydraulic Main and Condenser. S. Carpenter. Explains the working of the wet main and what the writer has found best in his experience. 2000 w. Jour of Gas Lgt—Dec. 7, 1897. Serial. 1st part. No. 17220 A.

Incandescent Mantles.

Some Tests on Incandescent Gas Mantles. E. A. Medley. Gives tests made in 1893 on one of the old A form of Welsbach burner, and on a group of five C burners, with recent tests on several makes of "mantles" which can be bought in England and in Germany. 1800 w. Elec Rev, Lond—Dec. 10, 1897. No. 17214 A.

Philadelphia Gas.

Municipal Gas in Philadelphia. John I. Rogers. The article contains the substance of a study made by the writer concerning the published statement of Mr. Dolan, that the works had been run at a loss for three years. A paper of interest in determining whether Philadelphia's municipal experiment was a failure. 6000 w. Munic Affairs—Dec., 1897. No. 17449 C.

The Philadelphia Gas Lease. Frederic W. Speirs. Gives the history of the gas franchise in this city, and discusses the terms of the lease, claiming that it proves nothing but the power of aggregated capital in politics. 4600 w Munic Affairs—Dec., 1897. No. 17448 C.

Retorts.

Billington's Patent Method of De-scurfing Gas Retorts. S. S. Mellor. Read before the Manchester District Institution of Gas Engineers. Describes a method which has given satisfaction at the Longport Gas Works, and is applicable to any works. Discussion. 2300 w. Jour of Gas Lgt—Nov. 30, 1897. No. 17060 A.

Retort Setting and Retort Heating. F. D. Marshall. A letter to the editor making objections in some respects to the system advocated by Mr. Carpenter in a paper recently published. 1700 w. Gas Wld—Nov. 27, 1897. No. 17001 A.

The Bronder Improved Apparatus for Discharging Retorts. Illustrated description as given in the specification. 3600 w. Am Gas Lgt Jour—Dec. 27, 1897. No. 17434.

Small Gas-Works.

The Application of Chemistry in the Management of Small Gas-Works. Suggestions of methods and description of tests that may be of use to a manager who is not a chemist. 2000 w. Jour of Gas Lgt—Nov. 23, 1897. No. 16972 A.

Water Gas.

Coal Gas or Water Gas? Abstract of a paper on recent progress in water-gas lighting by Dr. Strache, with criticism by E. Körting. Translated from *Journal für Gasbeleuchtung*. 1300 w. Gas Wld--Nov. 20, 1897. No. 16926 A.

Welsbach.

Proposed Amalgamation of the Welsbach Companies. Indicates the scope of the scheme, and reports its adoption. 2000 w. Gas Wld—Nov. 27, 1897. No. 17002 A.

The Original Welsbach Patent. Translated extract from the specifications of the original patent with much valuable information. 5800 w. Pro Age—Dec. 15, 1897. No. 17,167.

SEWERAGE.

Baltimore, Md.

Baltimore Sewerage Plans. A sewerage commission has recommended the construction of sewers costing about $10,500,000. Describes the conditions existing and the system adopted. 2000 w. Eng Rec—Dec. 18, 1897. No. 17186.

Cleveland, Ohio.

Walworth Run Sewer, Cleveland, O. A circular sewer of concrete and brick on an oak grillage was built under difficult conditions by methods described. 1000 w. Eng Rec—Dec. 18, 1897. No. 17187.

River Purification.

The Purification of the Thames. William Joseph Dibdin. Abstract of paper from Proceedings of the Institution of Civil Engineers, (England) Vol. CXXIX. Considers the work of effecting the purification of the sewage, in freeing the river from this pollution, and the best method of effecting further improvements. 2400 w. Jour W Soc of Engs—Oct., 1897. No. 17089 D.

Sewage Pumps.

The Pumping Engines of the Charlottenburg Sewage System. (Die Pumpmaschinen der Kanalisation von Charlottenburg.) Illustrated description of fine compound pumping engine on the Riedler system, at Charlottenburg, near Berlin, with plate of working drawings, and data of tests. 1000 w. 1 plate. Zeitschr d ver Deutscher Ing—Nov. 13, 1897. No. 17326 D.

Sewage Purification.

Sewage Disposal and Water Purification. Charles Francis. Urging action to prevent cities discharging their sewage into streams or water courses, and commending the methods of broad irrigation and intermittent downward filtration. 3500 w. Munic Engng—Dec., 1897. No. 16965 C.

Sewage Purification in Rural Districts. J. Aldersey Davenport. Advocates the use of intermittent downward filters. 1000 w. San Rec —Nov. 19, 1897. No. 16928 A.

The Purification of Sewage at Cologne. (Klärung der Kanalwässer der Stadt Köln.) Report of Prof. Fraenkel upon the best method of purification. Sedimentation is recommended in two pools alternately emptied and cleaned. 3500 w. Gesundheits-Ingenieur—Nov.. 15, 1897. No. 17362 B.

The Purification of Sewage by Bacteria. Samuel Rideal. Explains the theory of the bacterial processes and gives an outline of the different methods. Discussion follows, 9500 w. Jour Soc of Arts—Dec. 17, 1897. No. 17451 A.

STREETS AND PAVEMENTS.

American Paving.

American Street Paving. Report of the committee of the American Society of Municipal Improvements, with letters and editorial. 5000 w. Eng Rec—Dec. 11, 1897. No. 17113.

WATER SUPPLY.

Boston, Mass.

Water Supply of Boston, Mass. Reports the danger of exhausting the water supply, and the precautions taken to guard against this, with other information of interest. 1000 w. Fire & Water—Dec. 25, 1897. No. 17437.

Buffalo, N. Y.

Buffalo Water-Works Intake Tunnel. Information relating to the construction of this tunnel, begun in July, 1895, and finished in Nov., 1897, at a cost of $90,000. 1200 w. Eng Rec —Dec. 18, 1897. No. 17185.

Contamination.

The Contamination of the Water Supply of Sauve. (Sur la Contamination de la Sourc e de Sauve.) The contamination of the water supply of this French town was traced by the appearance in the water of the reactions of fluoresceine, which had been placed in the suspected drains. 1000 w. Comptes Rendus—Nov. 29, 1897. No. 17322 D.

The Contamination of Wells. (Sur lar Contamination des Puits.) M. Duclaux. A note to the French Academy, showing dangers of well water, and the distance and nature of soil through which contamination occurred in a village in the Department of Cantal, France. 1200 w. Comptes Rendus—Dec. 6, 1897. No. 17324 D.

Field Work.

Investigations of Water-Supply. F. H. Newell. Description of the field-work carried on in various parts of the country. 3500 w. Trans Am Inst of Min Engs—Nov., 1897. No. 16955 D.

Impure Water.

An Insanitary Object Lesson. Perry F. Nursey. A statement of the negligence and ignorance displayed in the town of King's Lynn, Eng., and the typhoid epidemic resulting from it. 2200 w. Ind & Ir—Dec. 10, 1897. No. 17225 A.

The Pollution of Water and Its Correction. Reginald Empson Middleton. Read before the Society of Engineers, London. Considers generally the sources of pollution, discusses legislation on this subject in England, gives the writer's solution of the difficulty in dealing with sewage, &c. 3500 w. Ind & Ir—Dec. 10, 1897. No. 17226 A.

Landsberg.

The Waterworks of the City of Landsberg on the Wartha, Prussia. (Das Wasserwerk der Stadt Landsberg a. d. W.) With full details of wells, pumping station and distribution for this city of 30,000 inhabitants. Two articles. 1 plate. 5000 w. Gesundheits Ingenieur—Nov. 30, Dec. 15, 1897. No. 17363 E.

New York.

Water Supply of Greater New York. Reviews the present supply of the annexed districts and of the city, with some account of the bills to be introduced at the opening of the State legislature. 1200 w. Fire & Water—Dec. 18, 1897. No. 17196.

Pumping Engine.

See Mechanical Engineering, Engines.

Pumping Plant.

A Gasoline Pumping Plant for a Town Water Supply. Description of the plant installed at Gibsonburg, Ohio, giving the form of guarantee accepted. 1100 w. Eng News—Dec. 23, 1897. No. 17260.

Reservoir.

Construction of the Jerome Park Reservoir. Describes the site and plan of construction, with the work now being executed. 2400 w. Eng Rec—Dec. 4, 1897. No. 17040.

The Bogamdani Tank Restoration. Some interesting engineering details in connection with this project are noted. 1000 w. Ind Engng—Oct. 30, 1897. No. 17004 D.

Water Mains.

Repairing a Water Main, F. G. Cudworth. Describes an unusual piece of work in the system of the Orange, Mass., waterworks, Ill. 400 w. Eng Rec—Dec. 11, 1897. No. 17114.

MISCELLANY.

Art.

Municipal Art. Frederick S. Lamb. Criticizes the attitude of the citizens of Greater New York to this subject, showing how money has been wasted, or improvements neglected until the work has become needlessly expensive ; compares it with foreign cities ; makes numerous suggestions. Ill. 6400 w. Munic Affairs—Dec., 1897. No. 17446 C.

Fire Alarm.

See Electrical Engineering, Telegraphy and Telephony.

Fire Danger.

See Architecture and Building, Construction.

Fire Risk.

See Electrical Engineering, Power.

Garbage.

Garbage and Refuse Disposal of Cities. Report of the Committee on Garbage and Refuse, of the American Public Health Assn. 4500 w. Munic Engng—Dec., 1897. No. 16966 C.

Lighting System.

Petroleum "Arc" Lighting. J. G. Dudley. Illustrated description of a lighting system which claims to give safety, simplicity and steadiness, with great brilliancy and economy. 3500 w. Pro Age—Dec. 1, 1897. No. 16948.

London Fire.

The Great City Fire. Editorial on the fire protection of London and the necessity of fire prevention. 1900 w. Engng—Nov. 26, 1897. No. 17423 A.

Police Service.

See Electrical Engineering, Telegraphy and Telephony.

Municipal Franchises.

Public Control, Ownership or Operation of Municipal Franchises. R. R. Bowker. Written from the point of view of the economist or citizen, with special references to electric lighting. Does not favor municipal ownership. 11000 w. Munic Affairs—Dec., 1897. No. 17444 C.

Municipal Lighting.

Municipal Electric Lighting. John R. Commons. A paper advocating municipal electric lighting, reviewing what has been accomplished, criticizing investigations made, aud studying the subject in general. 14000 w. Munic Affairs—Dec., 1897. No. 17445 C.

New York.

Greater New York a Century Hence. George E. Waring, Jr. A brief forecast of future conditions, based on present tendencies. 2000 w. Munic Affairs—Dec., 1897. No. 17447 C.

Playgrounds.

City Playgrounds. Editorial on the necessity for municipal action in securing playgrounds in our large cities, with report of what has been done in Philadelphia, Boston and New York. 1700 w. Gar & For—Dec. 8, 1897. No. 17-052.

Pleasure-Grounds.

Neighborhood Pleasure-Grounds in Boston. F. L. Olmsted, Jr. A description of these places of recreation and the special features for the healthful exercise of the people. Ill. 2300 w. Harper's Wk—Dec. 25, 1897. No. 17-242.

Public Improvements.

Municipal Public Improvements and the Laws Governing Them. David Molitor. Presents a scheme for the organization of a board of public improvements as would best serve a municipality of from two to three hundred-thousand inhabitants. 2500 w. Munic Engng—Dec., 1897. No. 16964 C.

Refuse.

The Disposal of Towns' Refuse. W. M, Watson. Part first discusses the various kinds of refuse to be disposed of in towns, the manner of utilizing most of it, and the destruction furnace, the heat of which can be used for generating steam for power, &c. 2200 w. Can Eng—Dec., 1897. Serial. 1st part. No. 17099.

Sanitation.

Twenty Years' Sanitation in an Urban District. James Young. A résumé of the advancement in all matters pertaining to the public health of the district of St. George, Bristol, England, showing an interesting record of progress and development. 1800 w. San Rec—Nov. 26, 1897. No 17003 A.

RAILROAD AFFAIRS.

NEW CONSTRUCTION.

China.

Railway Prospects in China. J. T. M. A summary of the arguments for and against the likelihood of rapid building. 1600 w. Ry Age—Dec. 17, 1897. No. 17194.

Leeds, England.

Railway Extension in the Leeds District. The improvements contemplated on the London and North-Western Railway, England. 600 w. Transport—Nov. 26, 1897. No. 17-006 A.

Review.

Railway Construction in 1897 and 1898. A general review of the work for 1897, with enumeration of the more important lines added, those still under construction, and for which contracts have been let. 1700 w. Ry Age—Dec. 24, 1897. No. 17438.

Russia.

Railway Construction and Management in Russia. Extracts from the report of the British Consul at St. Petersburg, showing the wonderful progress in construction. 1000 w. Transport—Dec. 17, 1897. No. 17431 A.

Southern United States.

Southern Railroad Extensions. D. Allen Willey. An account of the new lines to be built which will aggregate 3000 miles, with a record of the railroad construction in the Southern States for the year 1897. 1500 w. Mfrs Rec—Dec., 1897. No. 17289.

Wales.

From London to South Wales Direct. An account of the new section of railway which will shorten the Great Western route. It is about 33½ miles in length and will cost a million sterling. The ceremony of cutting the first sod is reported. 1700 w. Transport—Dec. 3, 1897. No. 17158 A.

MAINTENANCE OF EQUIPMENT.

Armored Cars.

R. R. Arsenals and Burglar Traps. Arthur H. Giles. Illustrated descriptions of devices to protect cars from railway robberies. 1400 w. R R Car Jour—Dec., 1897. No. 17108.

Box Car.

Standard Ventilated Box Car—Louisville and Nashville R. R. Describes and illustrates a car of 60,000 lbs. capacity, adapted to the conveying of either ordinary or perishable merchandise. 1600 w. R R Car Jour—Dec., 1897. No. 17107.

Brakes.

The Chapsal Electro-Pneumatic Brake. George Leonard. Abstract of a paper before the Society of Civil Engineers of France. Also editorial. Description of the apparatus, principally in its application to the Westinghouse Automatic Air Brake. The editorial shows the futility of inventing apparatus for working the air-brake, and discusses the advantages claimed. 3800 w. R R Gaz—Dec. 24, 1897. No. 17411.

Car Heating.

Heating Passenger Cars. William Garstang. Abstract of a paper read at the November meeting of the Western Ry. Club. Traces the progress made, and discusses the systems in use, noting points that need special attention. 3000 w. Ry & Engng Rev—Dec. 25, 1897. No. 17299.

Carriage Lighting.

Railway Carriage Lighting and the Latest Experiments with Acetylene. From the *Zeitung des Vereins deutscher Eisenbahn-Verwaltungen*. Reports the experiments made by the Berlin firm of Messrs. Julius Pintsch, with criticisms and comments. 1800 w. Ry & Engng Rev—Dec. 4, 1897. No. 17044.

Coke Car.

80,000-pound Coke Car—Buffalo, Rochester and Pittsburgh Railway. Illustrated description. 500 w. Loc Engng—Dec., 1897. No. 16938 C.

Fireboxes.

See Mechanical Engineering, Boilers.

Freight Cars.

The Passing of the Wooden Freight Car. Editorial on the changes taking place in the construction freight equipment. 1300 w. Am Eng & R R Jour—Dec., 1897. No. 16983 C.

Freight Trains.

The Making Up of Freight Trains Partially Equipped with Air Brakes. Edward Grafstrom. States the prevailing custom and discusses whether or not it is the best. 1400 w. Eng News—Dec. 23, 1897. No. 17259.

Locomotives.

Bogie Tank Engine—London, Tilbury, and Southend Railway. The principal dimensions and weights with description of a powerful engine, with engraving and working drawings of large size. 1300 w. Engr, Lond—Dec. 17, 1897. No. 17422 A.

Brooks Consolidation Engine for the Mexican Central Railway. Illustration, dimensions and general particulars. 500 w. Loc Engng—Dec., 1897. No. 16940 C.

Computations for Compound Locomotives and their Steam Consumption. (Berechnung der Verbundlokomotiven und ihres Dampf-verbrauches.) A comparison of the compound and simple engine based upon indicator diagrams. A valuable mathematical paper by Inspector Leitzmann. Two articles. 8000 w. Zeitschr d ver Deutscher Ing—Nov. 27, Dec. 4, 1897. No. 17334 G.

Four-Cylinder Compound Locomotive for the London and North-Western Railway. Illustrated description with leading particulars of a new type of engine possessing features of interest. 800 w. Engng—Dec. 3, 1897. No. 17119 A.

Hand Starting Valve for Compound Locomotive. (Neuer Wechselkolben mit Handbewegung für Verbund-Lokomotiven.) Von Borries improved starting valve enables the engineer to convert the locomotive from compound to simple, and *vice versa*, at will. 1000 w. 1 plate. Glaser's Annalen—Dec. 1, 1897. No. 17356 D.

Mountain Express Locomotives. (Die Bergschnellzug Lokomotiven.) A general discussion of locomotives intended for heavy grades at fair speeds, with especial reference to the engines of the Austro-Hungarian and Italian railways in comparison with those of other countries. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 26, 1897. No. 17340 B.

New Experimental Locomotive "Schenectady No. 2," Purdue University. Illustrated detailed description with editorial. 2500 w. R R Gaz—Dec. 17, 1897. No. 17173.

The Gilderfluke Locomotive. Eli Gilderfluke. A humorous parody of the many complicated engines which have appeared from time to time. 3000 w. Loc Engng—Dec., 1897. No. 16937 C.

Trials of English Locomotives. Report of the trials of two English locomotives that were invited to remain in France after the closing of the Paris Exhibition of 1889, to run trial trips.

The leading dimensions are given, also editorial. 2800 w. Engr, Lond—Nov. 19, 1897. No. 16915 A.

Twelve-Wheel Locomotive for the Chicago and Eastern Illinois. Elevation and principal dimensions. 400 w. R R Gaz—Dec. 24, 1897. No. 17413.

Two New Geared Locomotives. Illustrated detailed description of the Heisler geared locomotive, and the Climax engine, with a discussion of the general question of geared locomotives, and the two classes into which they may be divided. Also editorial. 3800 w. Eng News—Dec. 9, 1897. No. 17069.

Lubrication.

Car and Locomotive Lubrication. Discussion of the paper presented by George W. Cushing. 10700 w. Pro West Ry Club—April, 1897. No. 17282 D.

Mineral Traffic.

Rolling Stock for Mineral Traffic. Illustrated description of the latest built cars used in the United States for this purpose, comparing the wooden and metal cars, the increase in size, &c. 1800 w. Ir & Coal Trds Rev—Dec. 17, 1897. No. 17457 A.

Repairs.

Charges for Repairs West of the 105th Meridian. George S. Hodgins. Discussion of differential charges. 1500 w. R R Car Jour—Dec., 1897. No. 17110.

The Cost of Locomotive Repairs and the Efficiency of Machine Tools in Railroad Shops. William Forsyth. Showing how to economize, taking into consideration the fact that the largest expense is for labor ; and also pointing out how tools can be made to do more work. 3600 w. Pro West Ry Club—April, 1897. No. 17283 D.

Sleeping Cars.

Second-Class Sleeping Car Rates. Editorial on the movement toward second-class sleeping-car service and describing the tourist cars. 900 w. Ry Age—Dec. 17, 1897. No. 17193.

Steam Pressure.

The Limits of Steam Pressure in Locomotives. G. R. Henderson. Outlines the probable limit of steam pressure in locomotives, and some of the difficulties in reaching and using such pressures. 1500 w. Am Eng & R R Jour—Dec., 1897. No. 16982 C.

Steel Cars.

Life of the Steel Car. Comments on the life of the steel car as compared with the wooden car, and the protection needed to prevent corrosion. 1100 w. R R Car Jour—Dec., 1897. No. 17106.

Swivel Truck.

The Busse Locomotive Swivel Truck. (Laufachseneinrichtung für Schienenfahrzeuge, Bauart Busse.) A form of single swivel axle to be used both forward and as a trailer for locomotives for use on sharp curves. 1200 w. Glaser's Annalen—Nov. 15, 1897. No. 17351 D.

The "Composite."

The "Composite" and Its Field. C. Peter Clark. Abstract of a paper read before the New England Railroad Club. Sets forth the advantages and qualifications of this car for certain uses. 2300 w. R R Gaz—Dec. 24, 1897. No. 17410.

Wagner Cars.

The Lake Shore Limited. Description and engravings giving an idea of the handsome appearance and conveniences of these cars, built for special service. 700 w. R R Car Jour—Dec., 1897. No. 17109.

MAINTENANCE OF WAY.

Curves.

Widening the Gage of Railway Track on Curves. William H. Searles. A study of the action of trucks and locomotives upon a curved track, showing that the widening is a simple mathematical problem. Also editorial. 3800 w. Eng News—Dec. 2, 1897. No. 16989.

Gage.

A Change to Standard Gage on the Columbia & Puget Sound Railroad. The method followed will be of interest to those interested in maintenance of way, 900 w. Ry & Engng Rev—Dec. 18, 1897. No. 17240.

Railroad Tracks.

Surfacing Railroad Track by Means of Compressed Air. Brief Description, with illustrations, of the method. 400 w. Compressed Air—Dec., 1897. No. 17280.

Rails.

Rails for the Eastern Chinese (Manchurian) Railroad. Illustrated description from the Government specification, of the style of rail and fastenings which have been adopted. 3000 w. R R Gaz—Dec. 10, 1897. No. 17091.

Superstructure.

The Superstructure of British Railways. (Les Voies des Chemins de Fer Anglais.) Comparing British and French railway construction, with sections of rails, chairs and joints used on the leading English railways. Two articles. 5000 w. 1 plate. Le Génie Civil—Nov. 27, Dec. 4, 1897. No. 17305 G.

Surveying.

Specifications for a Railroad Resurvey. G. W. Chance. Treats of general measurements, transit work, photographic survey, leveling, platting, etc. 2000 w. Ry & Engng Rev—Dec. 25, 1897. No. 17298.

Tunnel.

The Line of the Left Bank of the Seine. (La Ligne de la Seine. Rive Gauche.) Describes the tunnel along the left bank of the Seine at Paris, through which the Orleans Railway is to be brought to the new terminal station on the Quai d'Orsay ; giving numerous sections of the tunnel at various points along the line. 2500 w. 1 plate. La Revue Technique—Nov. 25, 1897. No. 17310 D.

SIGNALING.

Block Signals.

Automatic Semaphore Block Signals on the Illinois Central. Illustrated description of these signals, with diagram of the electric circuits by which they are automatically moved. 2200 w. R R Gaz—Dec. 3, 1897. No. 16970.

The Application of Current Formulas to the Siemens Block System. (Die Stromlauf-Formeln und ihre Anwendung zur Schaltung Siemens'scher Blockwerke.) A mathematical investigation of the conditions of operation of the Siemens and Halske system of block signaling, with many practical examples. Four articles. 1 plate. 12000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 12, 19, 26, Dec. 3, 1897. No. 17339 H.

Electric Signaling.

The Applications of Electricity to Railway Signaling. J. Warren. Treats of some of the applications for this purpose, giving illustrations. 1200 w. Elec, Lond—Dec. 3, 1897. No. 17127 A.

Germany.

Electro-Pneumatic Signaling: Bavarian State Railways. An account of the installation of the Westinghouse electro-pneumatic system of signaling. 800 w. Engng—Nov. 26, 1897. No. 17013 A.

Interlocking.

Interlocking Plant at Hammond, Ind. Illustrated description of one of the largest interlocking plants in the United States. 700 w. R R Gaz—Dec. 17, 1897. No. 17174.

Semaphore Signal.

The Union Electric Semaphore Signal. Illustrated description of a signal operated by an electric motor placed in a box at the base of the post. 2000 w. R R Gaz—Dec. 3, 1897. No. 16971.

TERMINALS AND YARDS.

New York Terminals.

The Railroad Terminals of New York. James F. Hobart. Part first gives interesting illustrated accounts of the stations of the Pennsylvania and the Grand Central, with brief reference to the changes that have been made and those in process. 1800 w. Ry Mag—Nov., 1897. Serial. 1st part. No. 17135 C.

Station.

The New Terminal Station of the Orleans Railway at Paris. (La Nouvelle Gare Terminus de la Compagnie d'Orleans, à Paris.) Plans and elevations of the competitive designs submitted for the proposed new railway station on the Quai d'Orsay, in Paris. 3000 w. Le Génie Civil—Dec. 11, 1897. No. 17307 D.

TRANSPORTATION.

Accident.

Report of the New York State Railroad Commission on the Garrisons Disaster. Abstract from the report giving valuable information regarding the construction of the track and roadbed at the point where the accident occurred. 3500 w. Eng News—Dec. 23, 1897. No. 17253.

The Garrisons Accident. Report of the investigation by the State Railroad Commission, as given in the *Albany Argus*. Illustrations of plan and sections presented. 1300 w. R R Gaz—Dec. 10, 1897. No. 17092.

The Garrisons Wreck. Summary of the report on the accident, by the New York State Board of Railroad Commissioners. 5000 w. Ry Age—Dec. 24, 1897. No. 17439.

Train Accidents in the United States in October. Detailed list with classified summary. 4500 w. R R Gaz—Dec. 3, 1897. No. 16968.

Earnings.

Heavy Railroad Earnings Continue. Report of the returns for November, which surpass all previous records in some particulars, giving tabulated statements of increases and decreases and other details. 1400 w. Bradstreet's—Dec. 11, 1897. No. 17104.

Freight.

The Movement of Freight on the German Railways in 1896. (Die Güterbewegung auf Deutschen Eisenbahnen im Jahre 1896.) Giving comparative tables with 1895, 94 and 93, especially as regards metals and ores. 1200 w. Glückauf—Nov. 27, 1897. No. 17370 B.

Pooling.

The Legalization of Pooling. Editorial giving views of prominent railroad men, with comments. 900 w. R R Gaz—Dec. 10, 1897. No. 17093.

The Railroads and a Pooling Bill. Discusses the present situation and the grounds of the railroad opposition to the bill. 800 w. Bradstreet's—Dec. 18, 1897. No. 17195.

MISCELLANY.

Anti-Trust Law.

Railway Associations. Aldace F. Walker. Explains what these associations are, and the work undertaken by them, showing the absurdity of attempting to subject them to the Anti-Trust statutes. 8000 w. Ry Mag—Nov., 1897. No. 17134 C.

Blacksmithing.

Kinks in Blacksmithing on the Louisville & Nashville Railroad. Description, with illustrations, of special methods in use. 2500 w. Loc Engng—Dec., 1897. No. 16939 C.

Inspection.

The Annual Inspection of the Boston & Albany Railroad. George W. Blodgett. Account of the inspection annually made on this road, with illustrated description of the principal features of the Dudley dynagraph car. 2000 w. R R Gaz—Dec. 17, 1897. No. 17175.

Irish Railway.

A Novel Irish Railway. Alfred Slater. Presidential address before the Gloucestershire Engineering Society. Describes a novel light railway built on the Lartigne system. A single-rail line. 1800 w. Arch, Lond—Dec. 17, 1897. No. 17452 A.

Light Railways.

Light Railways. J. B. Corrie. Describes

and illustrates a car, invented by E. R. Calthrop, for transporting standard railway waggons over narrow gauge lines. 2000 w. Ind & Ir—Nov. 26, 1897. No. 17027 A.

New Zealand.

Railway Results in New Zealand. Facts from report of Mr. Cadman, Minister of Railways, showing the results of the past year to be very satisfactory. 1200 w. Transport—Dec. 10, 1897. No. 16906 A.

Ownership.

State versus Private Railroad Ownership. Leonard Darbyshire. Discussion of the arguments advanced in favor of state ownership. 3400 w. Ry Mag—Nov., 1897. No. 17136 C.

Queensland.

The Railways of Queensland. Report of the past year showing increase in earnings and improvements under discussion. 1300 w. Trans Nov. 19, 1897. No. 16935 A.

Railways.

Railways and the Public. John W. Noble. Address at Purdue University. A discussion of some of the mutual obligations of railroad corporations and the people. Some of the statements made have been challenged by H. P. Robinson of Chicago. 7500 w. Ry Age—Dec. 10, 1897. No. 17098.

Railway Schemes.

Railway Schemes in Parliament. Editorial comment on projects in England for the improvement and extension of the railways. 2500 w. Engng—Nov. 26, 1897. Serial. 1st part. No. 17012 A.

Safety.

Safety and Economy in Railway Operations. (Betriebssicherheit und Oekonomie in Eisenbahnwesen.) A paper before the German Railway Society by Herr Haarmann discussing German, English and American statistics, from 1881 to 1895, showing the close relation between safety and economy, in the operation of railways. 10000 w. Glaser's Annalen—Dec. 1, 1897. No. 17354 D.

South Wales.

The South Wales Railway Struggle. A statement of the projects for extending the railways. 900 w. Engr, Lond—Dec. 3, 1897. No. 17125 A.

STREET AND ELECTRIC TRAMWAYS.

Accumulators.

The Use of Accumulators in Central Stations of Electric Tramways. Ludwig Schroeder. Abstracted from a communication to the *Elektrotechnischer Verein*. Describes their use on Zurich-Hirslanden line, the Brockenzell-Lettnang line and the Remscheid line. 1500 w. Elec Rev, Lond—Nov. 26, 1897. No. 17015 A.

Basle.

The Extension of the Tramway System of Basle. (Die Erweiterung des Netzes der Basler Strassenbahnen.) With details of this overhead trolley system, including power house, wiring, cars, and motors. Four articles. 7500 w. 1 plate. Schweizerische Bauzeitung—Oct. 30, Nov. 6, 13, 20, 1897. No. 17364 H.

Central Stations.

See Electrical Engineering, Power.

Conductors.

Discussion of the Existing Systems of Conductors for Electric Tramways. (Betrachtungen der Ueblichen Stromzuführungs systeme.) A critical comparison between overhead, underground and accumulator systems. 6000 w. Deutsche Zeitschr f Elektrotechnik—Nov. 15, 1897. No. 17387 B.

Conduit Construction.

Conduit Railway Construction of the Metropolitan Street Railway Company, of New York. Illustrated account of this extensive work, with reasons for selecting this system. 4800 w. St Ry Jour—Dec., 1897. No. 16978 D.

Double-Deck Car.

The Latest Double-Deck Street Car. Illustrated description of a steel-built car, convertible into an open or closed car, having a central vestibule and double entrance. 600 w. Ry Rev—Nov. 27, 1897. No. 16936.

Electric Locomotive.

Four-Wheel Electric Locomotive for Main Line Service. (Zweiachsige Elektrische Lokomotive für Vollbahnen.) Illustrated description of 20-ton electric locomotive for overhead trolley, designed by the *Allgemeine Elektricitäts Gesellschaft* of Berlin. 2000 w. 1 plate. Glaser's Annalen—Nov. 15, 1897. No. 17352 D.

Electric Traction.

Gerry on Electric Traction. Discussion of paper by M. H. Gerry, Jr., on "Electric Traction, Notes on the Application of Electric Motive Power to Railway Service, with illustrations from the Practice of the Metropolitan Elevated Road of Chicago." 3800 w. Trans Am Inst of Elec Engs—Oct., 1897. No 17078 D.

Electrolysis.

Two Cases of Electrolysis. Very full illustrated account of damage to water-pipes in Salt Lake City and in Chicago. 2500 w. St Ry Rev—Dec. 15, 1897. No. 17203 C.

Elevated Roads.

A New Suspended Electric Railway. (Un Nouveau Chemin de Fer Electrique Suspendu.) Description of the Romanow suspended road for the rapid transmission of small parcels, now on exhibition at St. Petersburg. 800 w. Moniteur Industriel—Oct. 16, 1897. No. 16494 F.

Increased Traffic on South Side Elevated, Chicago. Reports a most satisfactory increase in the number of passengers carried since the road began using the new Union Loop. 500 w. R R Gaz—Nov. 5, 1897. No. 16371.

Single Track Elevated Railroads. (Einschienige Hochbahnsysteme.) With illustrations of a number of actual installations of roads in which the cars are suspended from a single rail. Serial. 1st part. 1500 w. Schweizerische Bauzeitung—Dec. 11, 1897. No. 17369 B.

Galicia.

The Lemberg Electric Tramways. Brief illustrated description. 600 w. Ry Wld—Dec., 1897. No. 17210 A.

Germany.

Electric Traction in Germany. J. L. Hermessen. Historical review since the first introduction in 1879. 2000 w. Elec, Lond—Nov. 26, 1897. No. 16999 A.

Glasgow Subway.

Glasgow District Subway. An examination of the financial results as given in the report of the first half year of the working of this railway. Makes comparison with the Liverpool Electric Railway and the South London Electric Railway. 2500 w. Ry Wld—Dec., 1897. No. 17212 A.

Lightning.

Protection from Lightnlng. Discusses the means taken to preserve the armatures of generators and motors from damage by electric storms, giving the experience in various cities. Ill. 2000 w. St Ry Rev—Dec. 15, 1897. No. 17199 C.

Power House.

A New Power House for Boston, Mass. Illustrated description of the new Harvard station, which represents the West End Ry. company's idea of the most economical railway generating station. Explains building and machinery. 1400 w. Eng Rec—Dec. 18, 1897. No. 17188.

Practical Operation and Maintenance of Electrical Equipment in the Power House. J. D. de Gurchy. Some of the troubles that have occurred in the writer's experience are discussed showing how serious losses may be averted, Ill. 1400 w. St Ry Rev—Dec. 15, 1897. Serial. 1st part. No. 17198 C.

The Largest Steam Plant in the World. Brief illustrated description of the proposed power station of the Metropolitan Street Railway Co. of New York. 1100 w. Power—Dec., 1897. No. 17200.

Rapid Transit.

Financial Characteristics and Operating Organization of the Brooklyn Rapid Transit System. Gives an idea of the organization and administration involved in the management of this property and some of the results achieved. 2000 w. St Ry Jour—Dec., 1897. No. 16979 D.

The Rapid Transit Situation In New York City. Editorial discussion of the decision of the Appellate Division of the Supreme Court, New York, which renders it very doubtful whether the enterprise can ever be carried out. 1200 w. Eng News—Dec. 23, 1897. No. 17258.

Shifting Engine.

Electric Shifting Locomotive. (Elektrische Rangier-Lokomotive.) Illustrating and describing an overhead trolley locomotive arranged to shift from one track and wire to another, for use in yard service. 2000 w. Schweizeirsche Bauzeitung—Dec. 4, 1897. No. 17368 B.

Stations.

See Electrical Engineering, Power.

Street Railway Lease.

A Hubbub in Boston. Analysis of the lease of the West End street railway of Boston, to the Boston elevated. 2500 w. Elec, N. Y.—Dec. 1, 1897. No. 16944.

Traction.

Electric Traction. Cloyd Marshall. Read before the Chicagc Electrical Assn. Reviews the indications of growing importance and the promising outlook for the application of electricity to heavy traction. 2500 w. Elec Wld—Dec. 25, 1897. No. 17251.

The Possibilities and Limitations of Electric Traction. Frank J. Sprague. Advocates the multiple unit system as opposed to the electric locomotive and train system, and predicts the entire displacement of the steam locomotive. 3000 w. Engineering Magazine—Jan., 1898. No. 17392 B.

Travelling Platform.

Travelling Platform with Two Speeds. (Plateforme Electrique à Deux Vitesses.) Report upon the scheme of MM. Blot, Guyenet and Mocomble for a continuous traveling platform as a means of transportation at the Paris Exposition of 1900. The motive power to be electricity and the platform to be elevated. 7500 w. Bulletin de la Société d'Encour—Nov., 1897. No. 17347 F+G.

Vienna.

The Vienna City Railway. (Die Wiener Stadtbahn.) A general account of the new elevated and depressed local railway in Vienna, with map and illustrations. Serial. 1st part. 7500 w. Glaser's Annalen—Dec. 1, 1897. No. 17355 D.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Clayton & Shuttleworth, 95 Queen Victoria St., London, E. C.=Illustrated catalogues. (*a*) Fixed and portable oil engines, giving specifications, approximate weights and dimensions, and instructions for ordering; (*b*) gas engines convertible into oil engines, giving description, prices, dimensions, and weights; (*c*) agricultural locomotives, engines, and wagons; (*d*) Hetts patent centrifugal pumps, with prices, weights and measurements, and interesting technical data; (*e*) general catalogue of boilers, portable and stationary steam engines, and agricultural machinery.

The Hazelton Boiler Co., New York.=Well-printed, well-illustrated, and well arranged and indexed catalogue of 150 pages, in handsome illuminated paper cover, being the sixth edition of the work, necessitated by improvements made in the boiler since the fifth edition was issued. Excellent half-tone illustrations show the works and the Hazelton boiler in course of construction and completed, as well as complete plants fully equipped with Hazelton boilers. The text, however, is broad in its scope, constituting a general discussion of steam-production, accompanied by useful tables and short articles from the writings of Prof. Thurston, William Kent, and C. W. MacCord.

Lambert Hoisting-Engine Co., Newark, N. J., U. S. A.=Large finely-illustrated catalogue of hoisting-, lowering- and swinging-engines of all sizes, and adapted to all classes of work and all modes of power application; also of traveling derricks, hoisters, horizontal engines and tubular boilers. The descriptive text is clearly worded and accompanied by full data of dimensions, power, and weight.

The Crosby Steam Gage and Valve Co., 75 Queen Victoria St, London, E. C.=General catalogue of gages, valves, and general engine and boiler fittings; prices are in most cases added, with list of users.

The Detroit Lubricator Co., Detroit, Mich., U. S. A.=Catalogue of sight feed and other lubricators. (*a*) Standard edition, giving full particulars of their various types of lubricators; (*b*) railway edition, giving similar information with special reference to locomotive work; it also gives particulars of the "Garfield" injector. Both are well printed.

Luke & Spencer, Ltd., Broadheath, near Manchester. Catalogue of grinding and polishing machinery and of their patent "consolidated" emery wheels; 109 types of tools are given with full specifications, and in some cases prices.

Ruston, Proctor & Co., Ltd., Lincoln, England.=Handsome illustrated catalogue of 177 pages, devoted to the various types of stationary and portable engines, centrifugal pumps, boilers, and agricultural and general machinery, made by this firm. Half-tone illustrations show the interior of their works in Lincoln.

The Graves Elevator Co., Rochester, N. Y., U. S. A.=Special illustrated catalogue of hydraulic, electric, steel-screw belt, and spur-gear elevators for passengers and freight, and of elevator cars, engines, and safety devices.

Hilles & Jones Co., Wilmington, Del., U. S. A. =Finely-illustrated catalogue of machine tools for boiler makers, bridge builders, car and locomotive builders, iron-ship builders, and workers in plates, bars, and structural shapes generally. The catalogue consists of a series of handsome plates with descriptive titles.

Henry Maurer & Son. New York.=Catalogue of fire-proof building materials of every description and for all purposes, illustrated with excellent perspective cuts, printed in two colors, of hollow tiles, partition and furring blocks, flue linings, and porous terra-cotta and of fire-brick and clay retorts. Half-tones show buildings in which the firm's products were employed.

Schäffer & Budenberg, Whitworth St, London Road, Manchester, England.=Catalogue of convenient size, fully illustrated, of pressure gages, valves, steam-engine governors, sluice valves, and a variety of boiler and engine fittings. Tables of weights and measures, properties of steam, and areas of arches; in general the information is very condensed.

J. H. Holmes & Co., Portland Road Works, Newcastle-on-Tyne, England.=(*a*) Catalogue of the "Lundell" continuous-current electric motors, with illustrations, sizes, and prices; (*b*) 40-page detailed list of some of the firms and steam ships supplied with "Castle" dynamos; (*c*) catalogue of the "Castle" dynamos and motors, showing these generators for belt driving, rope driving, dynamos with flywheels and direct connected on the Willans-Holmes system; prices and dimensions and instructions for telegraphic ordering are given; (*d*) loose sheets showing illustrated applications of the Lundell motors for printing-machinery and other purposes.

Robey & Co., Ltd., Globe Works, Lincoln, England.=Well arranged illustrated catalogue of steam engines, and boilers for marine and land service, with specifications for their types of feed pumps. Dimensions are all given both in the English and metric systems.

Bolling & Lowe, 2, Laurence Pountney Hill, London, E C.=Trade review for the year 1897, embracing in its scope both home and foreign trade. The subjects especially referred to are: the engineering strike in Great Britain; railway, canal, and water-way traffic; government ownership of railways; steel rails; steel for ship-building; tin plates; municipal improvements; extensions of ports and dry-dock yards; currency question. A very business-like review, which the firm offers to send to any part of the world, free of charge.

For Additional Catalogues see page 36.

THE
ENGINEERING MAGAZINE

VOL. XIV. MARCH, 1898. No. 6.

THE GOLD MINES OF THE WITWATERSRAND, SOUTH AFRICA.

By John Hays Hammond.

II.—PROBABLE VALUE, APPROXIMATE DURATION, AND MINING LAWS OF THE REGION.

IN my preceding paper, discussing the geology of the Rand, I defined the several reefs constituting the workable ore bodies of the portion of the region under description. While there is, compared with other auriferous reef deposits, a remarkable uniformity in the width and richness of the reefs, they are by no means homogeneous in respect of these features. The pay-ore occurs chiefly in large patches or zones, though sometimes in well-defined shoots. The intervening portions of the reefs, while usually auriferous, are of considerably less value than the pay zones referred to. The same condition of ore occurrence obtains in following the reefs in depth, but, as far as we are able to judge from past experience, which extends to the development of an aggregate of upwards of one hundred miles upon the reefs, the occurrence of poorer zones seems to be compensated for by the recurrence of richer zones.

On the other hand, comparison between more remote claims shows great differences in their relative values. As may be inferred from the above description, the percentage of non-payable ore in a claim varies in different parts of the Rand. Concurrently with reduced working costs, which are gradually being effected, the payable zones become extended, and the percentage of barren patches correspondingly diminished. While it is difficult to arrive at an approximation of the relative amount of non-payable and payable ground, I think a conservative estimate would be that upon the payable reefs of

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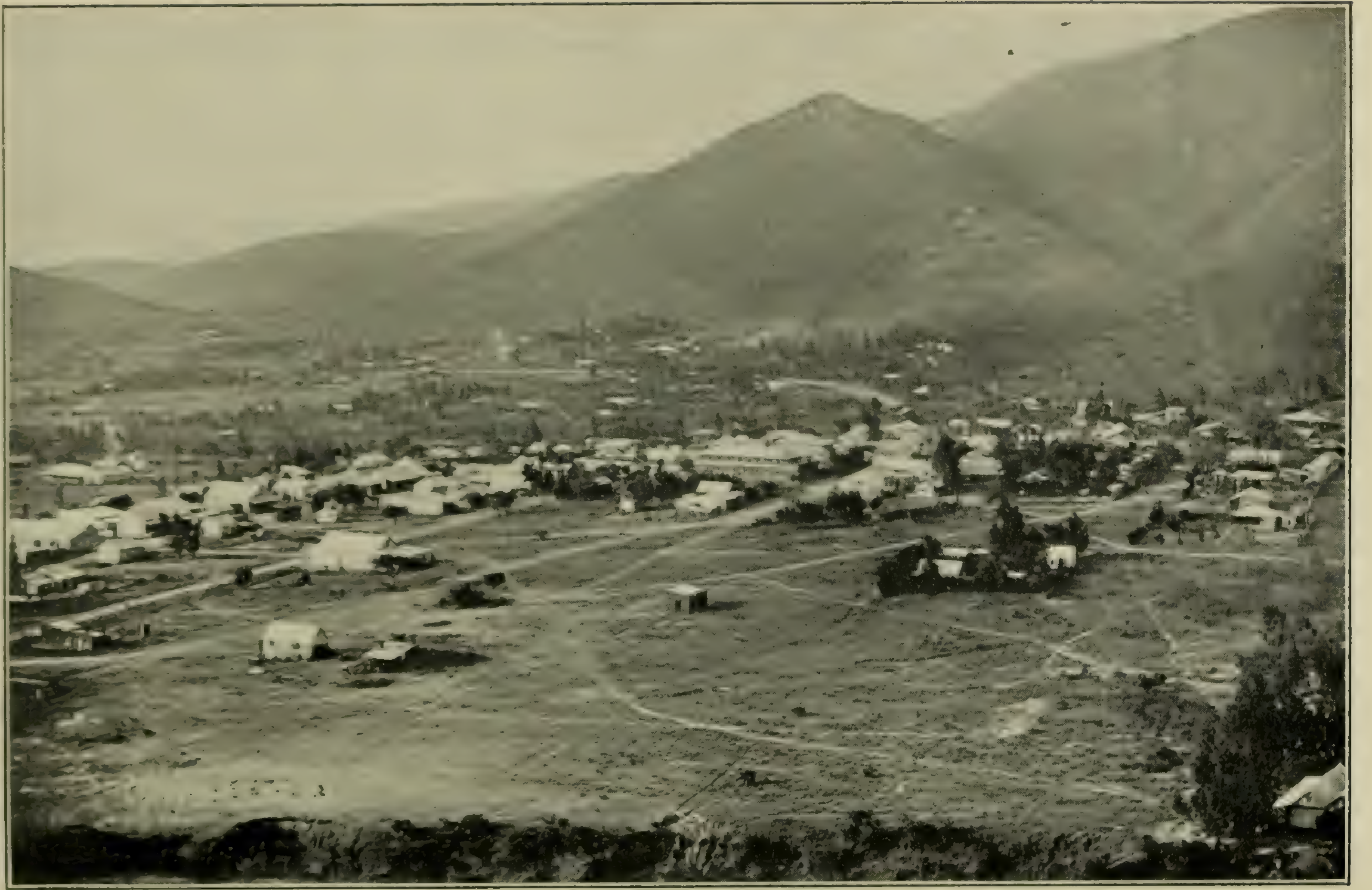


GENERAL VIEW OF BARBERTON, THE PIONEER REEF GOLD-MINING CITY OF SOUTH AFRICA.

By permission of the Art Photograph and General Publishing Co., London.

the central section of the district two-thirds of the ground opened up may be mined with profit. To those unfamiliar with the unique conditions of the Witwatersrand deposits, the estimates made by mining engineers as to the gold contents of the reefs seem hazardous on account of the apparently inadequate developments. Careful engineers, as the result of extensive experience upon the Rand, however, have estimated the gold contents of the central section of this district, which embraces an extent of 11½ miles along the course of the reef within workable depths, at £400,000,000. Estimates of the gold contents of the reefs to the east and west of this section are confessedly more unreliable, although Dr. Hatch computes the available gold from these portions of the Rand at £200,000,000. To apprehend the large quantity of estimable gold of the Rand, it may be stated that the entire output of the auriferous gravels and of the quartz veins of California, from the inception of mining operations to the year 1886, is about $1,280,000,000—a little more than one-half that of the central section just referred to.

AN INCLINE SHAFT IN THE SIMMER AND JACK MINE, 800 FEET UNDERGROUND.
By permission of the Art Photograph and General Publishing Co., London.

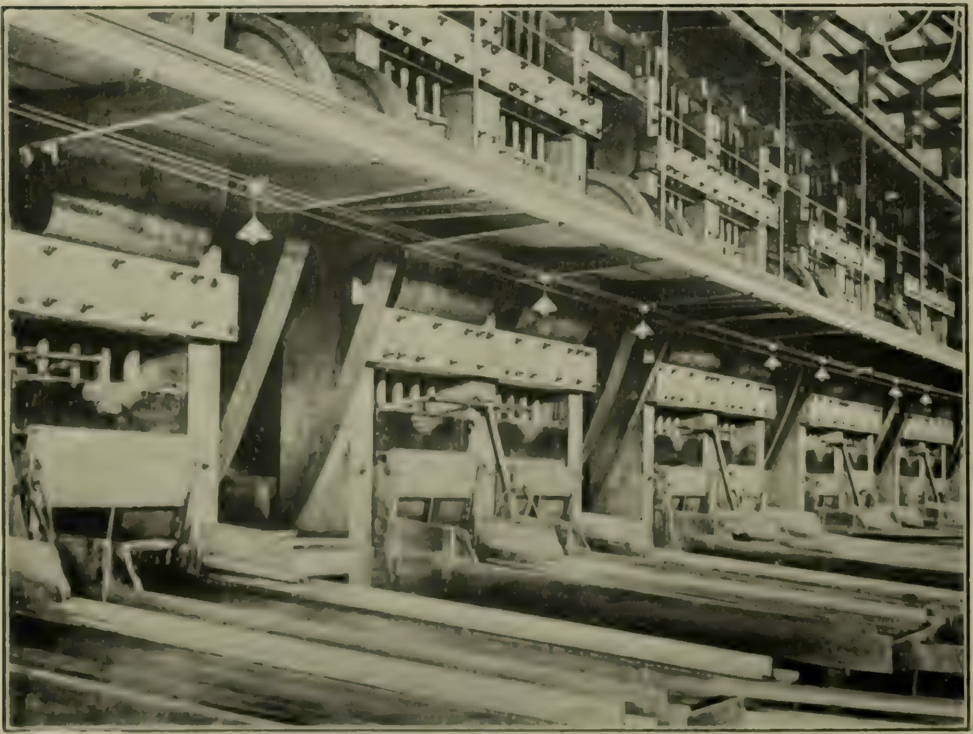
Curiously enough, by far the most valuable portion of the Witwatersrand deposits is in the immediate vicinity of Johannesburg, though the location of the town was not determined with respect to the supposed position of the richer section of the district.

The following table shows the total gold production of the Witwatersrand:

Year.	Ounces.	Dwts.	
1887	23,125.	8	
1888	208,121.	14	
1889	369,557.	5	
	42,000.	0	estimated unrecorded production for 1887, 1888, 1889.
1890	494,817.	0	
1891	729,268.	6	
1892	1,210,868.	16	
1893	1,478,477.	3	
1894	2,024,163.	12	
1895	2,277,640.	4	
1896	2,280,892.	4	
Total	11,138,931.	12	

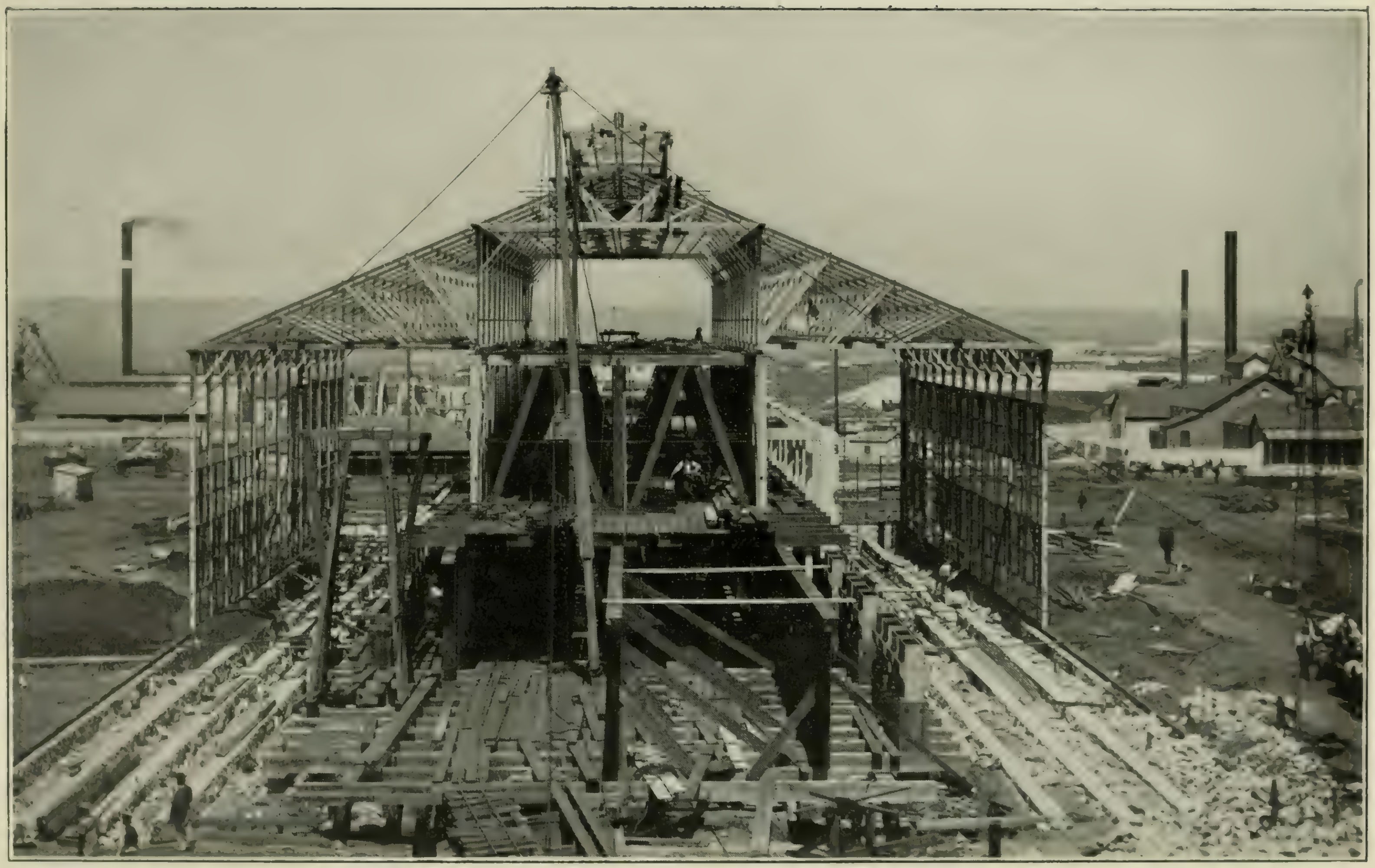
During the first ten months of 1897 2,427,838 ounces have been recovered, and the probable output (estimating the returns for November and December) for the year 1897 will be 3,000,000 ounces.

The stamping capacity of the Rand has been considerably in-

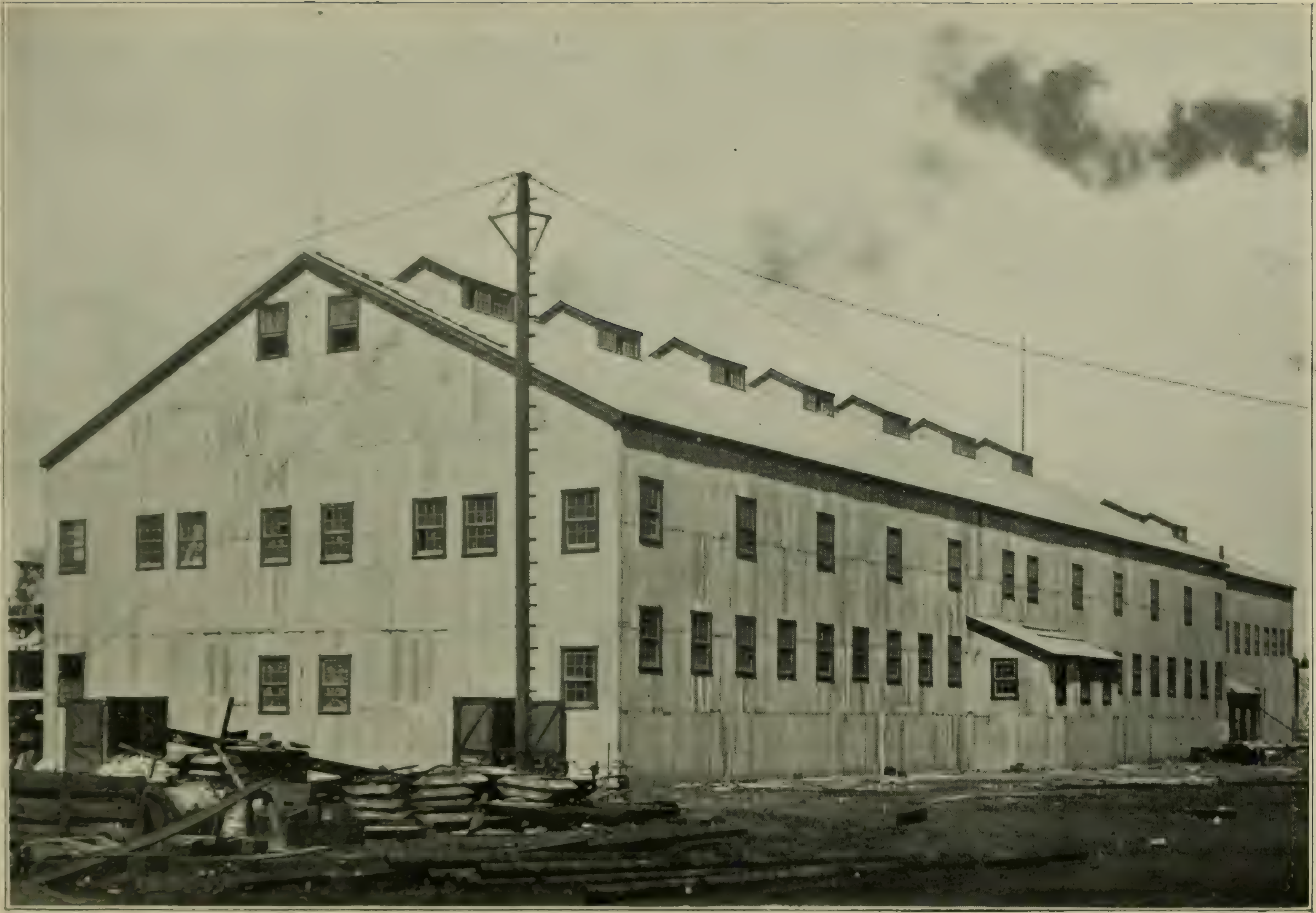


INTERIOR OF A BATTERY, CROWN REEF GOLD-MINING CO. LTD., JOHANNESBURG.

By permission of the Art Photograph and General Publishing Co , London.



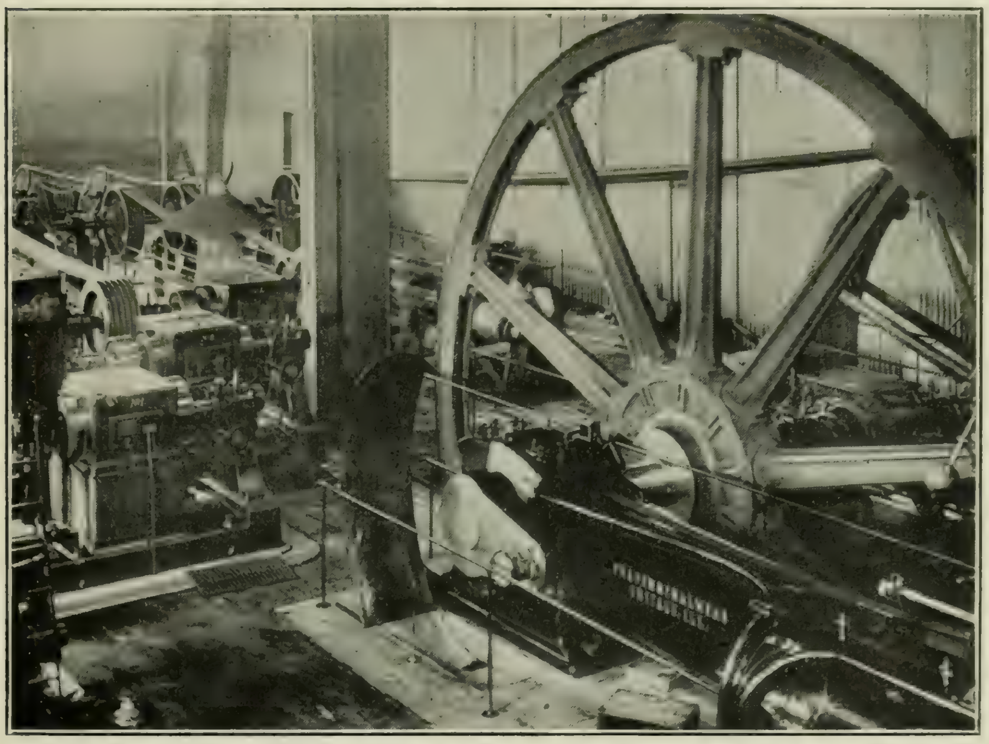
NEW 280-STAMP BATTERY AT THE SIMMER AND JACK MINES—THE LARGEST IN THE WORLD.



STAMP MILL, CROWN DEEP MINE.

creased during the past year; to-day there are 4,635 stamps. A large percentage of these stamps have been erected upon low-grade properties in what is called the outside districts of the Rand principally, and will not be able to crush profitably unless considerable economic reforms are made by the government. These reforms have been urged by the burghers themselves, and must ultimately be granted.

Including the stamps in course of erection, and those whose immediate erection is contemplated, the number of stamps is about 5,700. Other properties will be developed, and the stamping power further increased, in the event of future reductions in mining costs, with the result that within a few years the annual output of the Rand will probably exceed £20,000,000.



ENGINE AND DYNAMO ROOM, CROWN REEF BATTERY.

By permission of the Art Photograph and General Publishing Co., London.

In the year 1896 in the Witwatersrand district 2,949 stamps were in operation, crushing 4,011,697 tons (of 2,000 pounds) during 308.65 days' milling. This is a stamp-capacity per diem of 4.4 tons. The mill yield was 1,501,492 ounces, equal to 7.48 dwts. per ton, having a value of £5,381,600, or £1. 6s. 10d.* per ton of ore crushed. The concentrates yielded 107,890 ounces the value being £393,736. The tailings yielded 662,998 ounces, equal to 4.72 dwts. per ton, having a value of £2,058,851, or 14s. 8d. per ton of ore milled.

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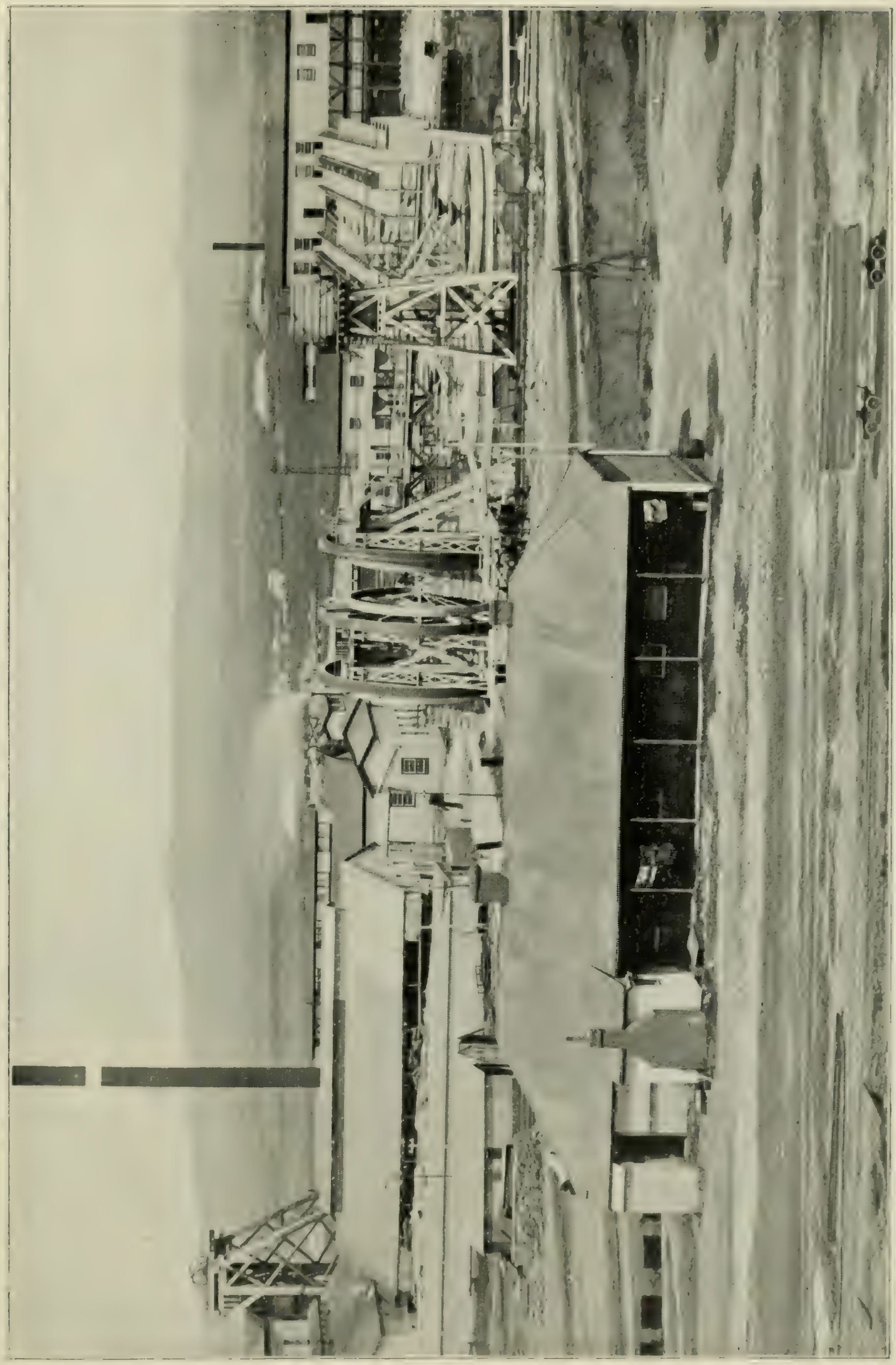
* Equal to $6.51 at the current rate of exchange, $4.85 for £1 sterling.

THE SIMMER AND JACK MINES, JOHANNESBURG, LOOKING EAST.

It is impossible to make any approximation of the life of the district, as the elements of uncertainty as to the feasible depth of future mining operations, the rapidity of exploitation, and other important points, are still indeterminate. Regarding the life of the Rand, I reiterate the opinion I expressed in an article contributed to the *North American Review* of February, 1897, wherein I said:

> Actual mining developments upon the deep-level areas, supplemented in turn by the results of the borehole explorations, confirm the theories advanced by the geologists, and justify the predictions that the life of the Witwatersrand district, from a mining point of view, is a long one; how long, though, it is impossible to accurately predict, having at present the indeterminate factors of the possible depth to which mining operations can be prosecuted, and of the rate of future annual exploitation.

NO 3. SHAFT. SIMMER AND JACK MINES.



THE SIMMER AND JACK CYANID WORKS.

To speak of the illimitable ore-deposits is, of course, hyperbole, but it will certainly take three decades, perhaps more, to exhaust the deposits of the central section to the depth to which mining operations are now considered practicable. The inevitable reduction of costs of future mining and the discovery of other payable deposits would undoubtedly tend to increase the longevity of the district. On the other hand, it is obvious that, if the developments of the lower areas should proceed more or less concurrently with, and not as the sequel of, the exploitations of the upper horizons, the life of the district will be correspondingly shortened.

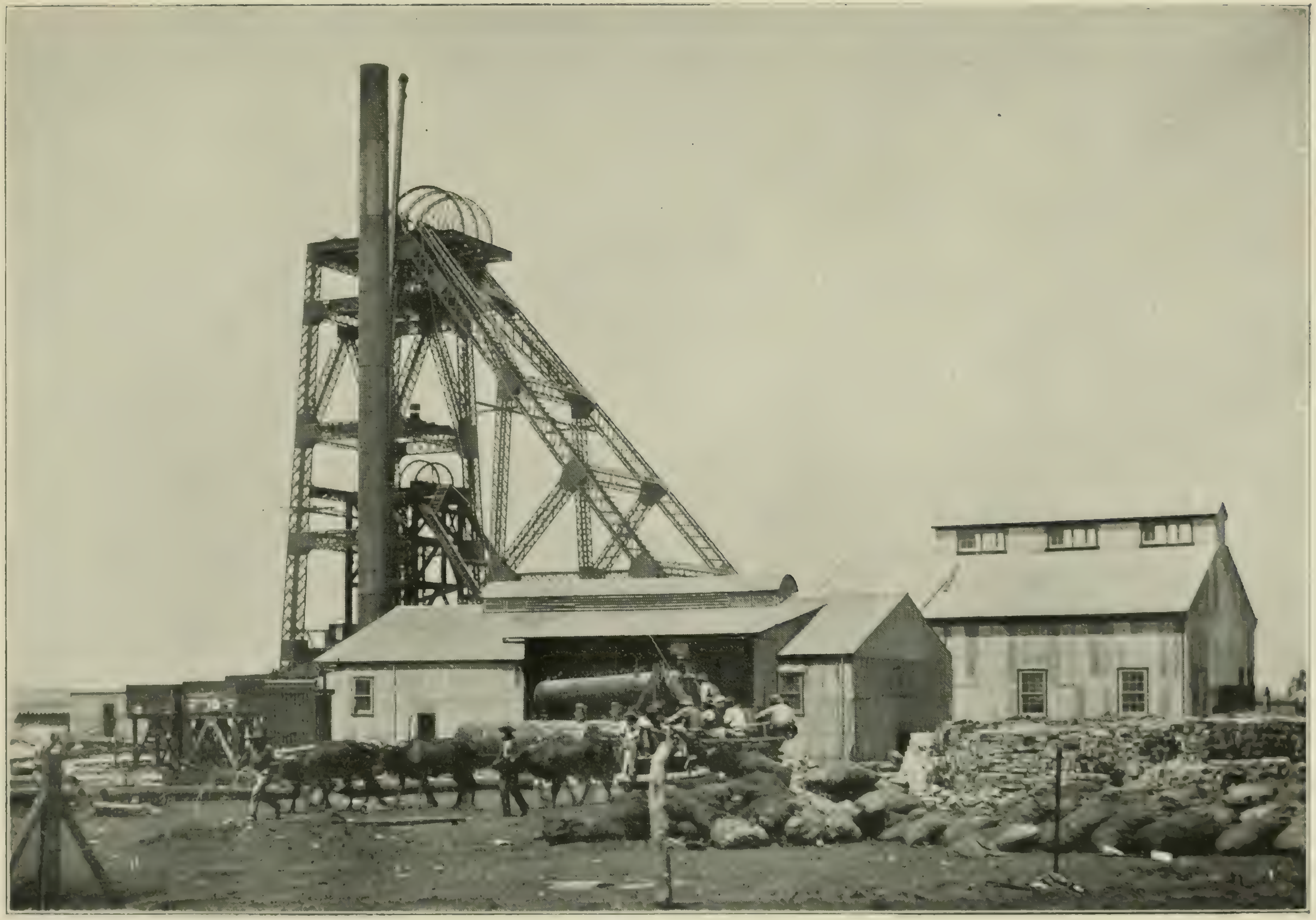
The rapidity of the development must, of course, be dependent to some extent upon the future mining laws of the country. Reference was made in the first article to the former statutes. The tenor of the existing laws can best be indicated by some extracts and abstracts, which follow:

CROSSING A RIVER IN THE TRANSVAAL.

By permission of the Art Photograph and General Publishing Co., London.

"The right of mining for and disposing of all precious metals and precious stones belongs to the State, but the State president, with the advice and consent of the executive council, may, by proclamation, throw open government ground as public diggings, upon which mining claims can be pegged off as specified by law."

An owner of a farm may, upon application to the government, have the farm likewise proclaimed. Before proclamation of a private farm the owner has the right of allotting to any person or persons he may specify a certain number of claims, called Vergunning claims,



NO. I SHAFT, ROBINSON DEEP MINE.

the number depending upon the size of the farm, but not to exceed a maximum of sixty.

The owner has the further right to reserve for himself for mining purposes one-tenth of the ground which is called a Mynpacht. This portion is held as a lease by the owner, under what is called Mynpacht brief, for a term of not less than five years, or more than twenty years, with the right of renewal. The rental on Mynpacht is 10s. per morgen (2.11 acres). A reef claim is 100 Cape feet (103.3 English feet), measured in the direction of the strike of the reef, by 400 Cape feet (413 English feet) in the direction of the dip of the reef,—equal to about 1½ acres.

The owner of the farm may also retain a certain area for residential and farming purposes, called a "werf" or "Homestead." The owner of a proclaimed farm is entitled to one-half of all licenses paid to the government.

Prospecting is not allowed on private ground without permission of the owner, but public government ground is open to prospectors, though claims may not be pegged out until after proclamation of the ground in question, as above described.

On private ground there is a charge of 5s. per month per claim for prospecting license, half of which goes to the owner, the government receiving the other half. On government ground there is a charge of 2s. 6d. per month, which goes to the government.

When, in the judgment of the mining commissioner, the results of the explorations justify, he may convert the prospecting licenses into a digger's license, after which a charge of 20s. per claim per month is made, provided ore is being crushed from the property. If, however, no ore is being extracted and crushed from the claim, the charge for the digger's license is 15s. per month.

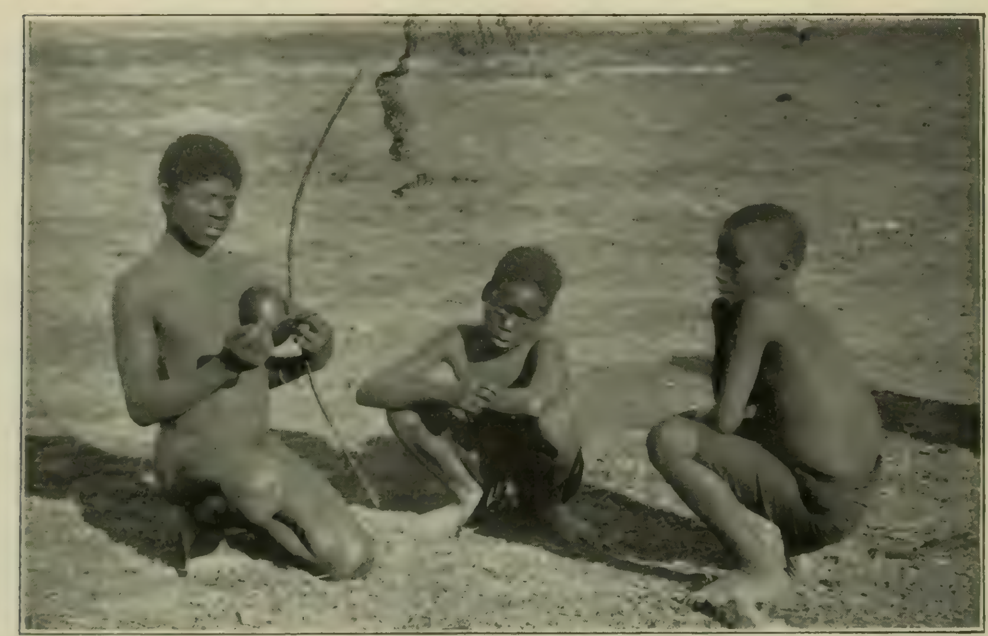
For 1896 prospecting licenses amounted to........	£620,000
digger's licenses......................	61,000
machine stand licenses.................	59,000

By the amalgamation of a number of claims, varying from 15 in the case of the smaller companies to 200 in the case of the larger, companies were formed in the first instance, and were called outcrop companies. These companies derived their name from the fact that the claims included the outcrop of the reefs and their contiguous claims. Subsequently the deep-level companies were formed by the amalgamation of residual claims sub-jacent to the outcrop property.

In order to offset the greater initial cost of plant, the deep level companies embraced a larger number of claims in their area. The majority of these have from 150 to 400 claims.

The term deep level is obviously a relative one, applied indeed in

PROSPECTORS PANNING FOR GOLD



"MUSIC HATH CHARMS," EVEN FOR KAFIR BOYS.

contradistinction to that of outcrop. But few of the present deep-level companies contemplate working through shafts to a greater depth than 2,500 feet. To equip a deep-level property to work at a depth of 3,000 feet with all the necessary shaft sinking, mining plant, and with a battery of 200 stamps, and the appurtenant tailings plant, involves an outlay of about £700,000. Many of the deep-level properties are already in operation, and returning very satisfactory profits.

The economic data of Witwatersrand mining will be given in the series of articles by Messrs. Webb, Yeatman, and Holms, which will appear in regular sequence in The Engineering Magazine during the next few months. The *résumé* of mining laws on the North American continent, prepared by my friend Dr. Rossiter W. Raymond, which immediately follows in this number of the magazine, affords an interesting standard for comparison with the legislation under which mining is conducted on the Rand.

MINING LAW IN BRITISH COLUMBIA, MEXICO, AND THE UNITED STATES.

By Rossiter W. Raymond.

AS Mr. Hammond remarks in the preceding article, the rapidity of development, and consequently the life, of a mining district must be dependent to a great extent upon the mining laws. Mr. Hammond indicates briefly the tenor of the present and former statutes thus affecting mining on the Rand.

The following brief summary* of mining legislation affords a basis for comparison in judging of the spirit of the laws of the South African republic, and estimating their relative effect.

The United States. The federal law relating to mines applies only to public land in certain States and territories, and concerns only the terms upon which mineral land may be occupied and purchased. Although extremely vague, difficult of construction in many cases, and productive of much uncertainty and litigation between conflicting claimants of title, it is very liberal towards explorers and locators, and, with all its faults, has undoubtedly stimulated an intense activity in prospecting and a consequently rapid, if somewhat wasteful and speculative, development of the mineral resources of the Rocky mountains and the Pacific coast. It is impossible to give here more than a bare outline of the main features of the system, as finally established in 1872.

All mineral deposits in public lands of the United States are free and open to exploration and purchase, by citizens and those who have declared their intention to become such. The discoverer of a mineral deposit (or the re-locator of an abandoned one) stakes out a claim, and records his location thereof, on payment of a trifling fee. (Special privileges are granted to discoverers of veins by tunnels.) Lode-claims (containing veins or lodes of quartz or other rock in place, bearing valuable mineral) cannot exceed 1,500 feet in length, or 300 feet in width on each side of the vein at the surface, or be restricted to less than 25 feet on each side the vein, unless pre-existing rights make this necessary. Placer-claims (containing any other form of deposit except "lodes") are limited to 20 acres for individuals and 160 for associations. Lode locators enjoy possession of the surface, and the ownership, to any depth, of all veins the apexes (upper edges) of which lie vertically under it, though the veins thus owned pass downward into adjoining lands. This so-called extra-lateral right is attended with a corresponding deduction from the title of the locator,—that is to say, the ownership of veins entering his land is vested in the owners of the locations which contain their apexes. Moreover, the extra-lateral right is dependent upon certain conditions in the location. This must have parallel end-lines, vertical planes through which are the boundaries of the said right. Until a locator has proceeded to purchase outright, he holds his claim by possessory title, subject to the fulfillment of local regulations. In this respect, the federal law makes but one regulation—that the amount of work annually done on each claim shall be not less in value than $100. Failure to observe these conditions forfeits the claim without any official notice, leaving the land open to occupation and re-location.

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* The publishers, at Mr. Hammond's suggestion, have obtained from Dr. Rossiter W. Raymond, secretary of the American Institute of Mining Engineers, the accompanying abstract of the mining laws of the United States, Mexico, and British Columbia. Dr. Raymond desires it to be understood that, by reason of the limited space available, his summary is necessarily far from comprehensive.

A complete title is obtained by application for a United States mineral land patent, survey by a government surveyor, advertisement of the application for 90 days, proof of the expenditure of not less than $500 in labor or improvements on the claim, and payment of $5 per acre and fees. If no adverse claim is filed during the period of advertisement, a patent issues upon the fulfillment of the other conditions named. The patent confirms, and renders independent of annual "assessment-work," the rights and privileges previously held under possessory title by the locator. In case of an adverse claim, the proceedings of the United States land office are suspended, until the adverse claim has been adjudicated by a court; a suit for that purpose must to be brought by the adverse claimant within 30 days.

No limit is set to the number of locations which may be held by one owner, and there is no restriction upon the transfer of possessory titles, or interests therein. Indeed, the mere fact of location withdraws the land from the public domain, and the holder of a patent is a private owner of real estate in fee, and, as such, can do what he likes with his property. Provision is also made for the location and purchase of mill-sites.

The price for placer-claims is $2.50 per acre. Coal-lands and salines are sold like agricultural lands, but at special prices.

It will be seen that the law grants the utmost freedom to explorers and miners, and that (apart from the trifling price per acre of claims patented) the government does not attempt to derive from its mineral lands any revenue. Mining is placed in this respect on the same footing as all other industries.

Mexico. The famous ordinances decreed in 1783 by the king of Spain are said to have been in some respects a codification of Aztec mining customs. After the establishment of Mexican independence, mining legislation was left largely to the several States, with much confusion as the result. In 1883 the States adopted an amendment to the constitution, authorizing the federal government to regulate mining for the whole republic. The mining code of 1884, framed under this authority, was an advance upon the previous condition of mining law in Mexico; but it was cumbered with minute details, harassing and discouraging to investors and adventurers. A more liberal statute came into operation July 1, 1892, and is now in force. Under this statute mines of gold, silver, platinum, mercury, iron, lead, copper, tin, zinc, antimony, nickel, cobalt, manganese, bismuth and arsenic, precious stones, rock-salt, and sulphur are granted by concession. Mineral fuel, mineral oils and waters, building materials, sand, clay, etc., and substances not included in the concessionary list, are the property of the owner of the soil, and may be worked freely without any concession. Mine-workings of both classes, however, are subject to State inspection and regulation. Any inhabitant of the republic may hold mining property. There is no distinction against aliens. Mining titles under concessions are perpetual and irrevocable, so long as the federal tax is paid. Such titles may be freely assigned and transferred, provided due report and registry of the change of ownership be made.

The unit of concession is always a vertical prism of indefinite depth, having for its external base a surface-square 100 meters on each side. This unit is indivisible. In cases where, between new concessions and older ones, space is left smaller than one unit, that space is also granted to the first applicant. In the granting of concessions, the explorer and discoverer of a new mine has preference, if he applies before the actual grant has been made. Otherwise, priority of application governs; and the applicant can have as many units as he is willing to pay for, so far as ungranted ground is available. The concession does not carry surface-ownership. But the mine-owner may occupy any surface land needed for mining. If it be private land, he must agree with the owners as to the terms of his use of it. If such agreement cannot be made, proceedings for legal condemnation are taken. The payments exacted are as follows. The *concessionaire* must pay $10 per unit (10,000 square meters) of his concession at the time of its issue. This is a stamp-tax, stamps to the required amount being placed on the patent issued to him. He must also pay an annual tax of $10 per unit, in three equal parts during the year, under penalty of fines and forfeiture. Finally, he must pay (with the exceptions specified below) an annual tax of 2 per cent. on the products of mining, without deduction for expenses. Mines of stone, coal, petroleum, iron, and quicksilver are exempt from this tax.

Metallurgical works and shops may be taxed up to $6 per $1,000 upon the value of their real estate and machinery.

On the public land, prospecting by boring, or by excavations not exceeding ten meters in depth, is free to all inhabitants of the republic. On private land the consent of the owner, or else a special executive permission, granted after due hearing, and upon security for damages, is required. The owner alone can authorize prospecting within buildings or their dependencies, and it is not permitted in towns. All mine-workings must conform to the rules made to secure safety and permanency. Otherwise, the owners have entire liberty, being responsible for accidents or damages caused by their neglect.

British Columbia. Like other provinces of Canada, British Columbia has its own mining laws. Omitting here the coal acts of 1888, and the act of 1897 for the inspection of mines to secure the safety and health of workmen, we have the placer mining act of 1891, amended in 1894, 1895, and 1896, and the mineral act of 1896, amended in 1897. According to these statutes, every "free miner"—*i.e.*, person or company holding a free-miner's certificate, which costs $5 per annum for an individual, $50 for a company having a nominal capital not exceeding $100,000, and $100 for one having larger capital—has the right to enter, locate, prospect, and mine upon any waste lands of the crown for all minerals except coal. In certain cases, where the lands are already lawfully occupied for other purposes (though the rights as to gold and silver have been reserved by the crown), he may be required to give security and pay damages to the prior occupants or owners.

Any free miner may locate a claim, as nearly as practicable, and not exceeding, 1,500 feet long by 1,500 feet wide; the form to be rectangular, unless pre-established boundaries interfere. The claim must be suitably marked with posts, and particulars thereof, together with affidavit of the discovery of mineral in place, must be furnished to the mining recorder for record. The holder of a claim is entitled to all minerals within it, but not to anything outside vertical planes drawn through its boundaries. (From 1884 to 1892 the British Columbia law was a practical copy of that of the United States, and granted claims 1,500 by 600 feet in size, with the attached extralateral right. There is still some litigation over the rights thus given to old locations, but the source of such trouble has been wisely closed.) The record entitles the locator to hold the claim for one year, and thereafter from year to year without re-recording, provided he keeps his miner's certificate in force and files proof of $100 worth of work done in each year, or pays $100 in lieu thereof, and records the official certificate of such facts. A lapse in respect to either of these two certificates forfeits all rights, and the claim is deemed vacant and abandoned. The interest of a free miner in his claim is a chattel interest, equivalent to a lease for one year, renewable from year to year, and subject to performance of the conditions of the act.

Any lawful holder of a mineral claim may obtain a crown grant therefor on the following conditions: (*a*) improvements to the value of $500 on the claim, or a payment of $500 in lieu thereof; (*b*) proof of the finding of a vein—*i.e.*, a body of valuable mineral-bearing rock in place—within the claim; (*c*) survey by a Provincial surveyor; (*d*) posting and advertisement of notice to apply for a grant after 60 days; (*d, e, f, g, h*) issue, after due filing of papers required, and in the absence of adverse claim within 60 days, of a "certificate of improvements." (Adverse claims suspend these proceedings, and must be pushed promptly and with diligence to judicial determination.) Upon the granting and recording of this certificate, the claim-holder is entitled to a crown grant of the claim on payment of $5 per acre, provided he applies for the same within three months. The crown grant for a mineral claim carries the mineral right and the use and possession of the surface (including timber) so far as necessary for mining. The other surface-rights are reserved to the crown or to the private owner, but the grantee of the mineral claim may purchase the complete surface-title besides, if the land be unoccupied, for $5 per acre. Crown grants for mill sites not exceeding 5 acres may be similarly had at $5 per acre; but these grants reserve the mineral right to the crown. It will be seen that, with regard to crown lands, the law contemplates the mineral right and the soil-ownership as two separate estates, and values each at $5 per acre, for sale under certain conditions to qualified applicants.

Placer claims are divided into creek claims, bar-diggings, dry diggings, bench-diggings, and hill-diggings. A creek-claim is 100 feet long and 100 feet wide—or more, if the distance across the creek from bench to bench is greater. In bar-diggings a claim is 100 feet long at high-water mark, and in width extends from high-water to low-water. In dry diggings and bench-diggings a claim is 100 feet square; and, in hill-diggings, it has a frontage of 100 feet along the ravine, and extends back to the summit of the hill. Larger claims are allowed to first discoverers. Placer-miners must have free miners' certificates. Claims must be recorded and re-recorded at $2.50 per annum, and must be worked every season, unless leave of absence is granted.

No direct tax or royalty is levied in British Columbia on the product of the mines, but all miners, whether employers or employed, must keep their miners' certificates in force. These may be paid for by a company, the amount being deducted from wages due.

THE ECONOMICAL UTILIZATION OF EXHAUST STEAM.

By Bryan Donkin.

THIS is a subject to which, in view of its great importance, sufficient attention is rarely paid, and in many mills and factories much waste is allowed. It is seldom remembered that it is necessary to economize heat when generated, as well as the coal used to produce it, and there is no more efficient means of doing this than to return some of the heat in the exhaust steam to the boilers. In power stations and plants where fuel is dear, costing, say, from 15s. to 25s. a ton, an important reduction in the consumption of coal, and hence an increased evaporative efficiency, results from the utilization of the exhaust steam to heat the feed-water, after it has done work in the cylinder. Either the exhaust from a single-cylinder engine, or from one of the last cylinders of a compound or triple engine, may be made to part with some of its heat, on its way to the condenser.

The most obvious method of accomplishing this object is to condense the whole, or part, of the steam, and produce a vacuum, thus obtaining more power from the engine, as compared with a non condensing plant, and reducing the fuel-consumption. To add a condenser to an existing engine generally results, in practice, if properly carried out, in a gain of 25 per cent. in steam-consumption. A mill proprietor in any locality may justly inquire of the engineer if the addition of a condensing plant will pay for the extra outlay incurred, including the air and water pumps, condenser, increased wear and tear, power and fuel required annually, etc. This will depend upon the local conditions, price of fuel, and whether water for the condenser can be had cheaply or for nothing. In most cases it has to be pumped, and this involves a small additional expense per year for the power required. All these circumstances should be considered before a decision is made.

Condensing plants may be divided into three types:

1. Jet condensers.

2. Surface condensers (marine type), the tubes being cooled by water.

3. Surface condensers exposed to the air, with both air and water circulating around the tubes to cool them.

Each of these three types requires an air pump.

Jet Condenser.—This is the old arrangement introduced by Watt; when used for mill purposes, it generally necessitates about 30 pounds of water per i. h. p. per hour. In this type of condenser the water, when discharged from the air pump, is generally greasy and not very hot, and is scarcely suitable for pumping back as feed-water. Nevertheless part of it is often sent on to the boiler; if not, it is usually run to waste. The quantity of water required is large, and the whole arrangement is uneconomical and seldom desirable. The vacuum obtained, however, is good, often 2 or 2½ inches below atmospheric pressure, and this method of condensing is cheaper than the two others. A water pump is generally necessary, but this depends on the depth at which water is found in the particular locality, and whether any river, pond, or well is available. If the supply is scarce, the same water can be used again and again by passing it through a cooling pond, and this is often done in cotton mills in England. In India and the tropics no great advantage for cooling purposes is gained by this arrangement.

Surface Condenser.—This type is very largely used at sea, on rivers and lakes and in water works; in the last-named case, the cold water is often pumped through the condenser into the mains of the district.

The condenser proper consists of a large number of small brass tubes, through which the exhaust steam is passed, the cold water circulating outside. The quantity of water required is considerable, but at sea or on rivers this presents no difficulty; the water is continually renewed, and no cost is incurred except for pumping. As the feed-water produced by the condensation of the exhaust steam is taken from the inside of the tubes, it is pure water, but contains much or little oil, according to the extent to which the steam cylinders and glands are lubricated. It is not very hot, the temperature being reduced by the cold circulating water. This type is now more often used than formerly on land as well as at sea, but it is dearer, and takes up more room, than the jet condenser. The maximum vacuum should be obtained, and the minimum quantity of cold water used, so that the feed-water may be as hot as possible. There is a good deal of risk in using this condensed steam to feed the boilers, if much oil is supplied to the cylinders, and in many cases on land the system has been abandoned because the grease enters the boilers and forms a coating on the furnace flues, causing them to collapse. Good efficient oil filters are a necessity, but it is extremely difficult with any filter to get all the oil out of the water. The simplest way is to use a minimum quantity in the cylinders, and to measure it out to the engine-drivers. At sea the water is generally circulated by centrifugal pumps driven

COMPARISON OF THREE TYPES OF CONDENSERS.

I.	II.	III.
Jet Condenser (*Old Type*). Old type on land only.	*Water Surface Condenser.* Marine and land type.	*Air and Water Surface Condenser.* Land type only.
Action.	*Action.*	*Action.*
By direct mixing. Condensed steam and jet of water mixed together and running to waste. Sometimes the water is used again and again from a pond, or tank, and run back into it for cooling.	By transmission of heat. Considerable quantity of circulating water, continually renewed, separate from the condensed steam. Exhaust steam inside the pipes and circulating water outside. Small brass tubes generally used.	By transmission of heat. Small quantity of water running over outside pipes; same water can sometimes be used again and again, if cooled. Condenser placed on roofs of buildings, wind and air having free access. Air propeller often used to cool the pipes, so that there is air as well as water-cooling. Cast iron, steel, or copper pipe is used.
Water-Supply.	*Water-Supply.*	*Water-Supply.*
Large quantity required.	Large quantity circulating water.	Smaller quantity required,—about equal to quantity of steam condensed.
Vacuum.	*Vacuum.*	*Vacuum.*
About 2½ inches under atmospheric pressure. Probable vacuum to be expected in ordinary work, about 27 inches of mercury.	About 3 to 3½ inches under atmospheric pressure, depending on temperature and quantity of circulating water. Probable vacuum to be expected in ordinary work, about 26 inches of mercury.	Often about 3½ to 4 inches under atmospheric pressure, depending on length of exhaust pipe to condenser, and tightness of joints. Varies in every case. Probable vacuum to be expected in ordinary work, about 25 in. of mercury.
Advantages and Drawbacks.	*Advantages and Drawbacks.*	*Advantages and Drawbacks.*
Cheapest first cost. Minimum space required. Large quantity of water, and is greasy after use.	Large quantity of circulating water required. More expensive and bulky than first type. Water from condensed steam greasy.	Less water required than in other types. Main difficulty, to keep joints of exhaust pipes perfectly tight. Condensed steam greasy. External surface pipes should be cleaned frequently from dirt, etc.

An air pump is required for all three types. Water circulating pump required for Types II and III, and often for I a water pump. The practical relative economy of the three types depends entirely on the amount of vacuum that can be obtained in the cylinder of the engine. With very great care they could all produce nearly the same vacuum. No **1** generally gives the highest vacuum; Nos 2 and 3 a much lower one. The choice of the type should be governed by local conditions.

by a special engine, coupled direct. The vacuum usually obtained is some three to four inches below atmospheric pressure. As in this type the circulating water is on one side of the tubes and the condensed steam on the other; the two do not mix as in the jet condenser. The heat is withdrawn from the steam and transmitted through all the tubes to the water, transmission being more or less efficient, according to the condition of the tubes, which are seldom clean. At sea salt water is used for cooling the tubes, and on rivers and lakes this water, whether clean or dirty, is pumped through the condenser.

The third type is also a surface condenser, suitable for land engines and boilers.

Instead of using a large quantity of circulating water, a much smaller amount, about equal to the quantity of steam condensed inside the pipes, is employed. The cold water is forced up by a small pump, and conducted very carefully over the external surfaces of the pipes, so that they may be very uniformly wetted. The pipes are vertical or horizontal, from one to three or four inches in diameter, and the whole apparatus is fixed and worked in the open air. If the situation is not sufficiently exposed to the wind, an air propeller is used, but this requires a little power and fuel. The water is sometimes used again and again, if a pond, or a large tank, can be provided. A certain amount is always evaporated into the air from the hot condensing pipes, and this needs to be replenished. The vacuum obtained is generally less than in the other types, owing to the leakage from the large number of joints in the exhaust pipes. A large number of these condensers are placed on the roofs of buildings in London and the neighborhood, and one of the practical difficulties experienced is to keep the joints tight. The tops of the high buildings in New York and Chicago would be very suitable positions for these condensers, affording plenty of air, but great care would be necessary with the joints to prevent leakage. If this type of condenser is fixed very near dwelling-houses in confined districts, the spray, mist, and fog produced sometimes give rise to complaints.

The characteristics of the three types of condensers, their mode of action, the results secured, and the advantages and drawbacks of each are summed up in tabular form on page 932.

Heating Feed-Water.—Where condensers cannot be applied, and water is expensive and space limited, the heat in the exhaust steam should be utilized for heating the feed-water, instead of condensing the steam.

A large number of feed-water heaters are now at work in England and America, and afford another example of the transmission of heat, though in a different way. They usually consist of a nest of small tubes with the exhaust steam on one side, the feed-water being pumped through the pipes on the other. In some mills exhaust steam can be used also for heating purposes in winter,—such as warming buildings or drying goods,—and any surplus after condensation should be applied to heating the feed-water, and returned to the boiler, if clean enough. In many of the London electric stations condensers of various types have been added to the formerly non-condensing steam plants, and in others, where no water is available, there are large feed-water heaters, utilizing part of the heat in the exhaust steam. With these appliances a large portion of the exhaust steam still goes to waste.

The question of procuring water cheaply is often one of great difficulty in London and other large cities, and sometimes also space for the surface condensers is not available. To allow the exhaust steam to escape uncondensed is, however, a disgrace to engineers. In all these types of surface condensers which act by transmission of heat provision should be carefully made for cleaning both sides of the small tubes at short intervals, as with dirty water and greasy steam thick coatings are very quickly formed. Both grease and dirt are bad conductors of heat.

Very hard water also produces a deposit of sulphate and carbonate of lime on the tubes. In the case of a factory or works having a large number of non condensing engines, one central surface condenser is sometimes used, and the various exhaust steam pipes led into it.

A special engine for driving the air pump, circulating water pump, and fan is necessary, but the only difficulty with this arrangement is to keep the joints tight. On ships the exhaust steam of the small auxiliary engines is now conducted into the main surface condenser, but a minimum quantity of oil must be used in the cylinder of small engines.

Another important application, now largely utilized in steamships, is to raise the temperature of the feed-water by the heat of the exhaust steam from the low-pressure cylinder. In locomotives the exhaust steam is now wholly relied on to create the induced draught, but more could be done with it. Here a large field awaits the inventor who can succeed in utilizing part of the heat of the exhaust steam to warm the feed-water without diminishing the draught. The method has been tried and partly adopted in France, with a fan for giving the induced draught. Of late years exhaust-steam injectors have been introduced to force the exhaust steam and feed-water together into the boiler, but care must be taken that it does not become greasy. The exhaust steam from the feed or donkey pumps of small engines should be utilized, and the heat in them put into the boiler feed-water. Injectors, in which the steam goes into the feed-water, are much more economical than ordinary cheap feed-pumps, as the latter consume an enormous amount of steam—much more than either the seller or the buyer realize. Makers should guarantee the quantity required by their pumps to force so much water per hour into the boilers. Feed-pumps driven by gas, oil, or electricity are in the majority of cases much more economical.

In all the various mills and factories the exhaust steam from steam pipes, jacketed pans, and other steam-heated apparatus should all be drained back to the engine, and pumped into the boiler hot. Exhaust steam contains so much latent heat that the hot water obtained from it by condensation should be treated with great care, and utilized wherever possible, instead of being carelessly run to waste into the nearest drain, as if it were cold or dirty. Attention to these details in large factories results in a considerable economy of heat, and the expense incurred is generally covered in about a year. At the writer's works the hot water from the steam jackets of the engines, and from all the steam pipes used for heating the buildings, and all the water from the steam-supply pipes, is conducted to a large hot-water tank, whence it is pumped back into the boiler.

To sum up, exhaust steam contains a large quantity of latent heat. Heat is expensive. In these days of small profits it is absolutely necessary to save money, and not to waste it. Engineers, therefore, should look to their heat wastes in all directions, abolish them where possible, and thus save their money.

SHIP BUILDING AS A PRODUCTIVE INDUSTRY IN GREAT BRITAIN.

By James McKechnie.

IV.—RATIO OF OUTPUT TO WAGES THE DECIDING FACTOR IN THE RISING COMPETITION.

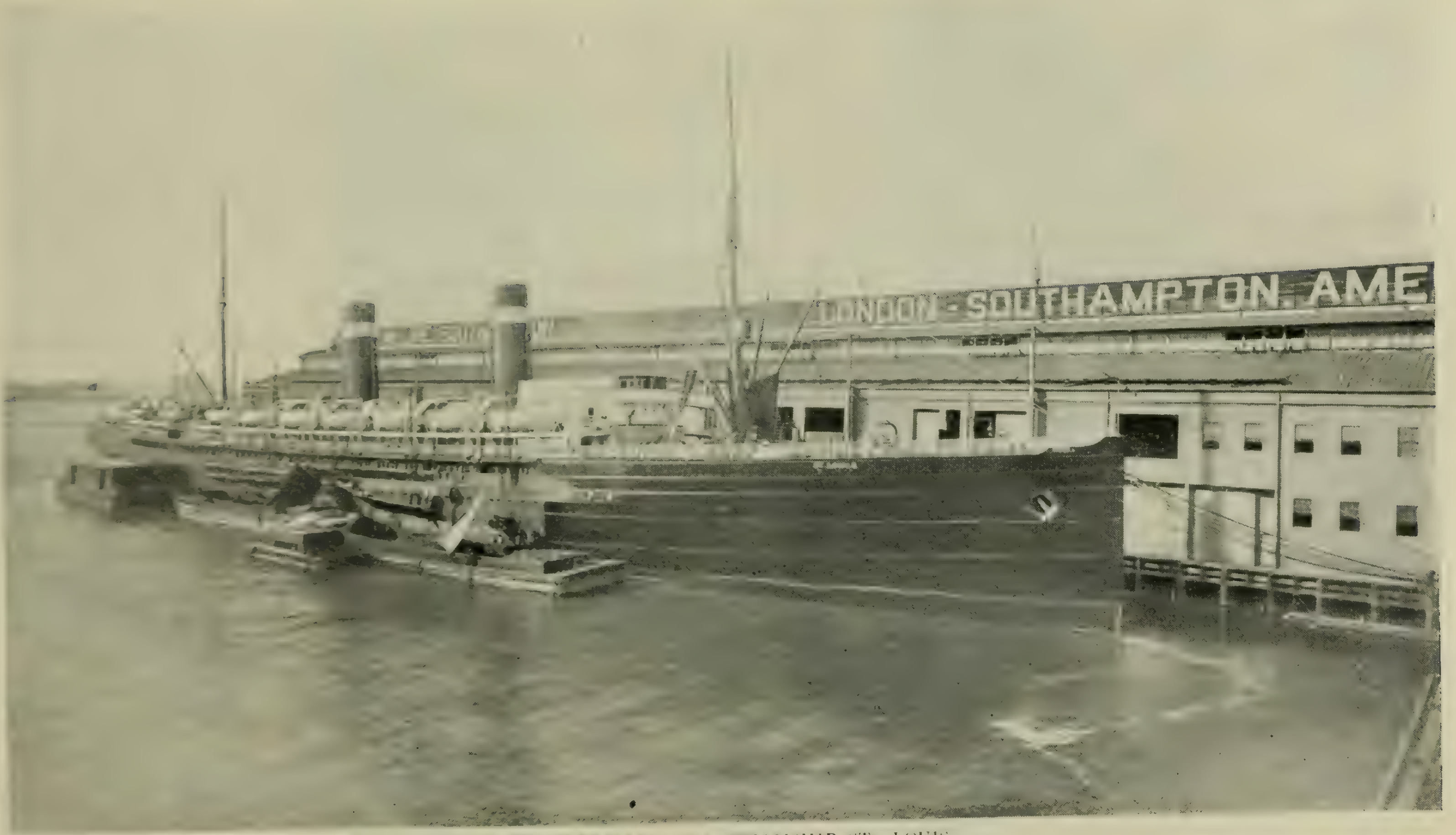
THE vessel-tonnage produced per annum in the United States is only about one-sixth of that produced in the United Kingdom; in Germany it is barely one-fifth, and in France much less. It is profitable to consider dispassionately not only the reason for this supremacy, but the prospects of future developments in other countries.

As I have said in a previous article, Britain's insular position made a fleet necessary, but early in the century the United States's wooden clippers, and France's vessels in a less degree, shared with her the shipping trade of the world. The possession of iron ore was not confined to England, but British builders more quickly recognised the possibilities of iron for construction and of steam for propulsion; and, more fortunately still, the declaration of a free-trade policy came to augment enormously the value of the artisan's wage at the right moment—at a time when discontent was in the bud. No attempt was made to reduce the rate or the sum of the wage,—it has all along been the other way—but the cheapening of the necessaries of life at once had its effect. Britain had a better fed, and therefore a more industrious, worker. The better qualities of man were quickened in direct proportion to his improved social conditions; the mind was developed, and work-problems were attacked with the greater courage. The value of labour was thus greatly enhanced, and there is no question that even to-day Britain's position among the nations continues to be due, amid increasing competition, to this higher average physical and mental status. The spirit of independence has been fostered; and, although it may from time to time assert itself in unfortunate ways, aspiration must always be in advance of attainment.

Another important factor is that England was "in" at the beginning. I can recall cases where owners pleaded with the builder to accept work at his own terms, the only stipulation being that the ship was to be hurried forward. Experience could thus be bought at the expense of the owner, who easily recouped himself, since competition had not yet tightened the purse-strings of the exporting agent. Now the ship builder of any country is no longer master of the situation,

THE JAPANESE CRUISER "KASAGI" AND THE YACHT "DOROTHEA" ON THE STOCKS AT THE SHIP YARD OF THE WM. CRAMP & SONS SHIP AND ENGINE BUILDING CO., PHILADELPHIA, PA., U. S. A.

but must meet the most stringent conditions ; still, England has the advantage of experience. It is true, as with all science, that she has been prodigal with out-gifts,—the pages of her scientific publications bear testimony,—but there is much that cannot be transmitted through the printing-machine, nor can the place of experience be taken by scientific or theoretical training. A friend who has been in correspondence with Mr. Charles Cramp permits me to copy part of a



THE AMERICAN LINE STEAMSHIP ST. LOUIS.

Built by the Wm. Cramp & Sons Ship and Engine Building Co. 534x63x42 feet ; 11,629 tons ; 20,000 i. h. p.

THE FLOATING DERRICK-CRANE "ATLAS" AT CRAMPS' SHIPYARD.

letter, hitherto unpublished, which gives his views on this very question. Mr. Cramp writes:

"The world—or, more particularly, the English-speaking world—is full of colleges, academies, institutes of technology, etc., engaged in educating young men to be 'scientific' naval architects, marine engineers, etc.

"These young men graduate early in their twenties, and are sup-

PART OF THE YARDS OF THE WM. CRAMP & SONS SHIP AND ENGINE BUILDING CO.

The bow of the U. S. S. "Alabama" is seen on the right.

posed—or suppose themselves—to be of thorough professional equipment. As a matter of fact, they are then hardly born—some of them but just conceived—in the professional sense ; but they are 'scientific,' they are masters of every formula, and perhaps, without ever having seen the inside of a shipyard or machine shop in actual operation, they at once begin to write 'professional papers,' and soon become known as 'authorities.'

"Thus, whenever any man of real equipment and actual experience undertakes to write about ships and ship-building, he is likely to be pounced upon by this brood, and the general public, not understanding a word that is said, and overawed by their facility in the use of obscure technical terms and by the profusion of their integral and differential calculus, will think they have the best of it.

LAUNCH OF THE EXPRESS STEAMER "KAISER FRIEDRICH."

17,500 tons displacement ; 28,000 i. h. p. Built by F. Schichau, Dantzig.

"This is not encouraging."

Mr. Cramp also makes it clear that the design of the St. Paul and St. Louis was a process of evolution from earlier ships "the details of which would fill the shelves of a library. . . . I am frank to say

AN AMERICAN-BUILT COASTWISE STEAMSHIP, THE "JUNIATA."

that, while I am the head of these works, and while my name is currently associated with the planning and building of these ships, they are actually the products of numerous minds ; their existence represents the essence, or the extract, so to speak, of many personalities.'' This is only characteristically magnanimous of Mr. Cramp, who has done so much for the industry in the United States : but it is incontrovertible that there must be a guiding head, equipped with experience to act as arbiter, receiving and encouraging the good and rejecting the bad. Therefore to Mr. Cramp is indeed due the success that has been attained in the two ships named, and that is traceable to his long association with ship building.

But there is always an inclination to overrate experience and the prestige it brings. The conservatism of contentment increases with years ; the aged keep saying : ‘‘ That which is is best,'' but happily there is, even in the old country, sufficient leaven of youth to keep the whole lump vigorous. The lesson which the impetuous activity of the United States is teaching in favour of labour-saving machinery of high productive capacity is slowly being realised in Europe. While wages in Britain have been lower, their purchasing value has been higher, but the ratio of product to wage has been less than in the United States. The advantage is undoubtedly with the British worker ; but in the United States, whether or not the worker has equal value in wage, the employer has the advantage over the British employer in view of the higher production per pound sterling of wage.* These are points not often pondered over, and yet they are of the essence of practical economics. The real problem of the future is, therefore, whether Britain, with her satisfactory wage value, can increase her productive capacity. In European countries the wage is low, and long hours and use of the same machine tools make the product nearly as cheap as Britain's.

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* The following figures have been deduced from the census returns by a correspondent in the Glasgow *Herald*.

	America in millions.	Britain in millions	Germany in millions.	France in millions.	Russia in millions.
Total value of a year's production.	£1,440	£845	£600	£463	£375
The average wages per year of all industry	£72	£42	£32	£36	£25
Average value of each person's production.	£388	£163	£112	£112	£78
Proportion of production value to wages.	5.4	3.05	3.5	3.1	3.13
Difference between wages and production.	£316	£121	£80	£76	£53

SHIP YARD OF F. SHICHAU AT ELBING, PRUSSIA.

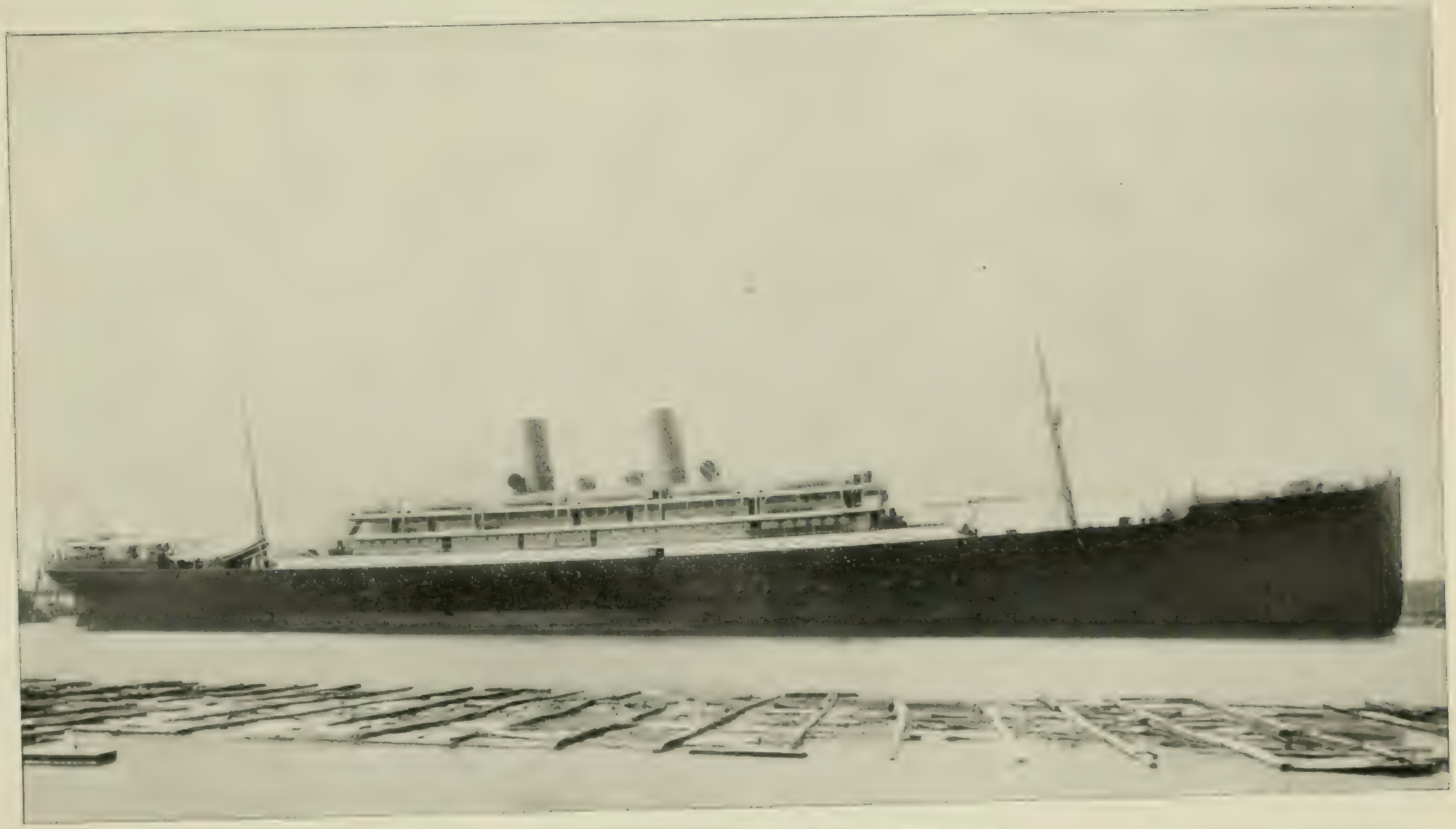
F. SCHICHAU'S SHIP YARD FOR LARGER SHIPS AT DANZIG.

Some general suggestion of the relative gross wage-earnings in different countries is difficult to arrive at, especially in view of the variations in conditions, and I do not care to accept here any statement which has been prepared with a purpose. Mulhall, in one of his latest books, gives the gross earnings *per capita*, which are not without indirect interest, and he shows that in the United Kingdom they are nearly 20 per cent. less than in the United States, although nearly 33 per cent. greater than in some of the European countries—notably Germany. This is not by any means overstating the difference in wage; one experienced engineer from the United States lately put it that the wages paid on the Clyde were only 55 per cent. of those paid in United States marine-engineering shops; and in some of the continental centres the wage per hour is little more than half what it is in Britain. But the rate of the wage is no criterion of the relative value, either to employer or worker. Food is cheaper in the United States; on an average, the worker there spends one-sixth of his earnings on food, whereas in Britain the worker spends one-fourth for that purpose, while in continental countries he can afford only one-third. As some one has said: "Bread and beer-swilling, and an occasional bit of sausage, cannot give strength sufficient to compete with you"; but the conditions are being rectified very rapidly. All the same, the British workman stands preëminent in this food question, for the statistician tells us that the Briton, on an average, consumes 110 pounds of meat, the German 75 pounds, the Frenchman 70 pounds, and the Belgian 56 pounds. Thus one can well understand that more work is done by the Briton; but whether the ratio is two to one, as is the rate of wage, is quite another matter.

MAIL STEAMER "PRINCESSE CLEMENTINE," IN THE OSTEND-DOVER SERVICE.

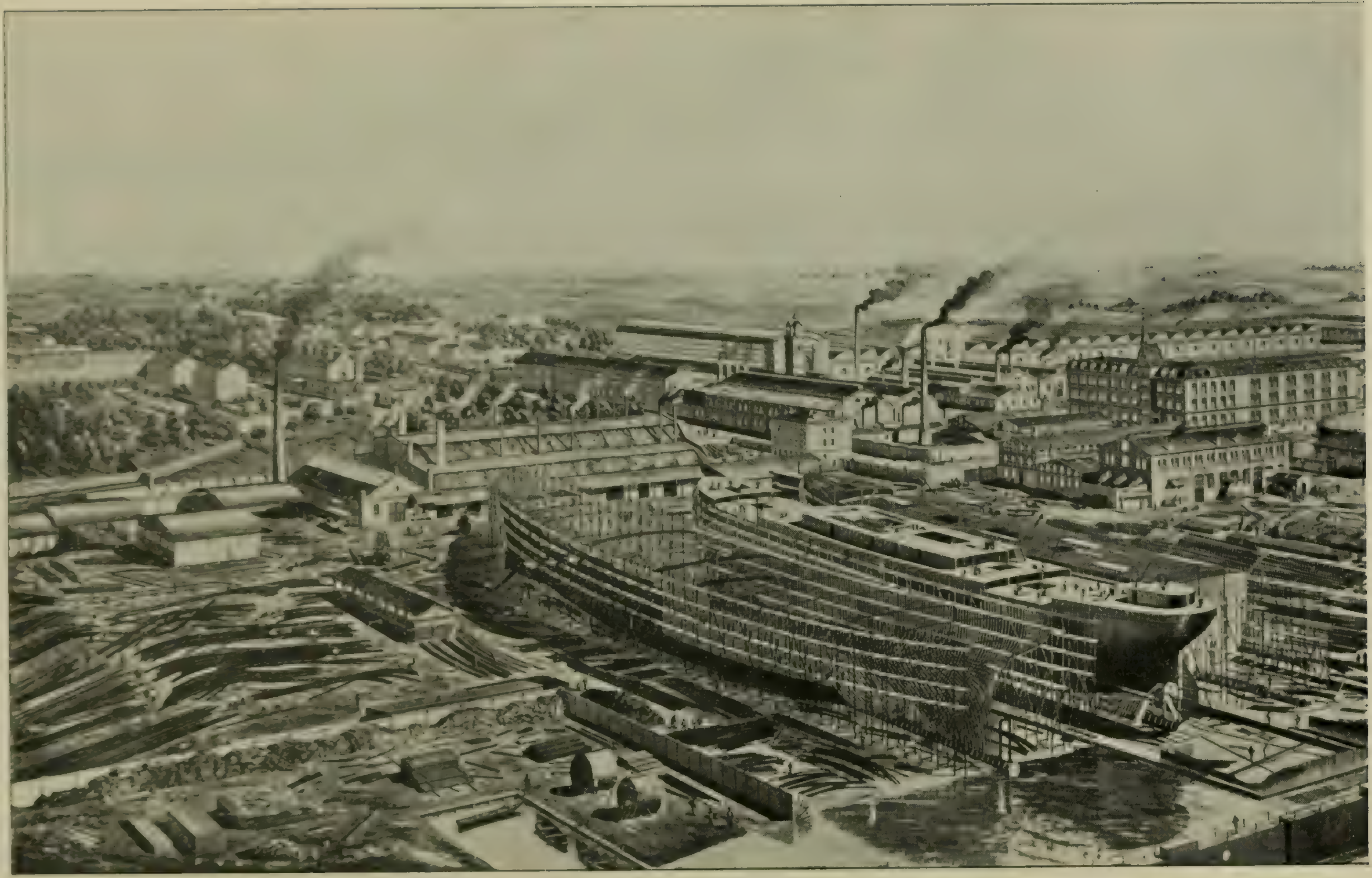
Built by the Société Anonyme John Cockerill, Seraing, Belgium.

But, while food is cheaper in the United States, other commodi-

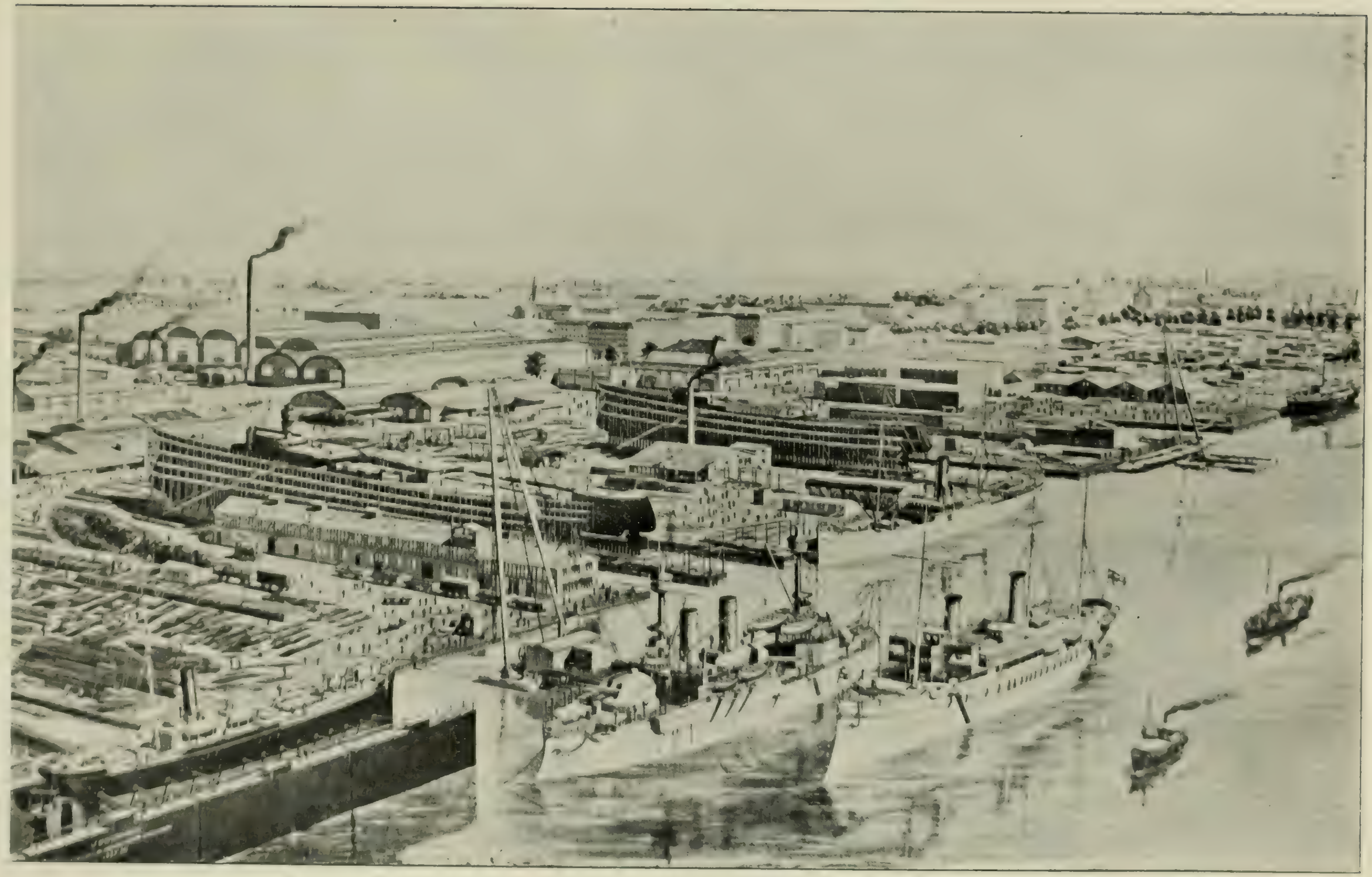


NORTH-GERMAN-LLOYD STEAMSHIP "BREMEN."

525×60×38 feet ; 8,000 tons displacement ; 18,000 i. h. p ; average service speed 14 knots. She has room for 2,300 passengers and 8,000 tons freight. Built by F. Schichau, Dantzig, 1896-7.



A PART OF THE SHIPYARD AND WORKS OF THE VULCAN COMPANY, STETTIN, PRUSSIA.



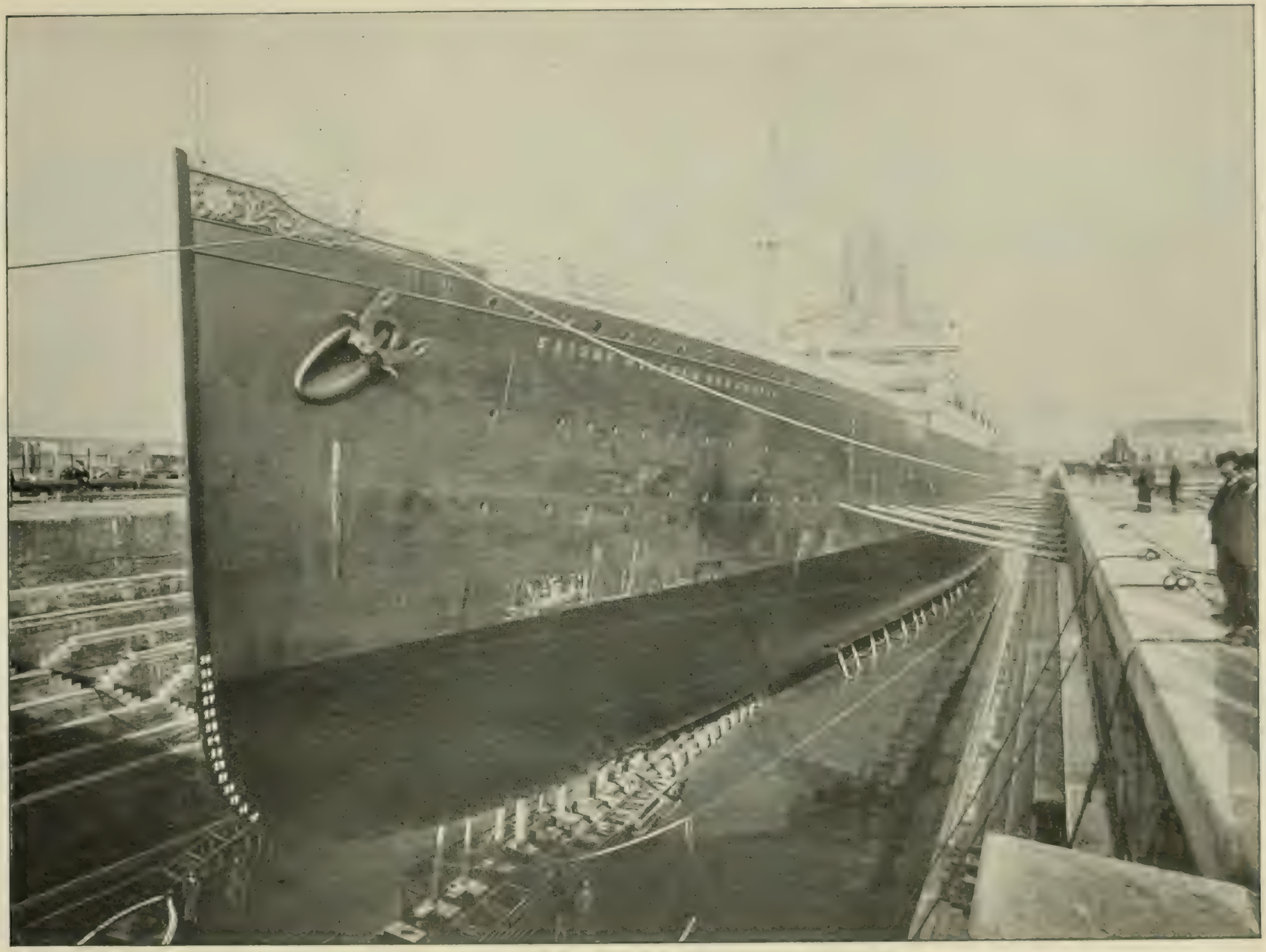
PART OF THE SHIPYARD AND WORKS OF THE VULCAN COMPANY, STETTIN, PRUSSIA.

This engraving, placed to the right of the one on the opposite page, forms a continuous panorama of the Vulcan Works.

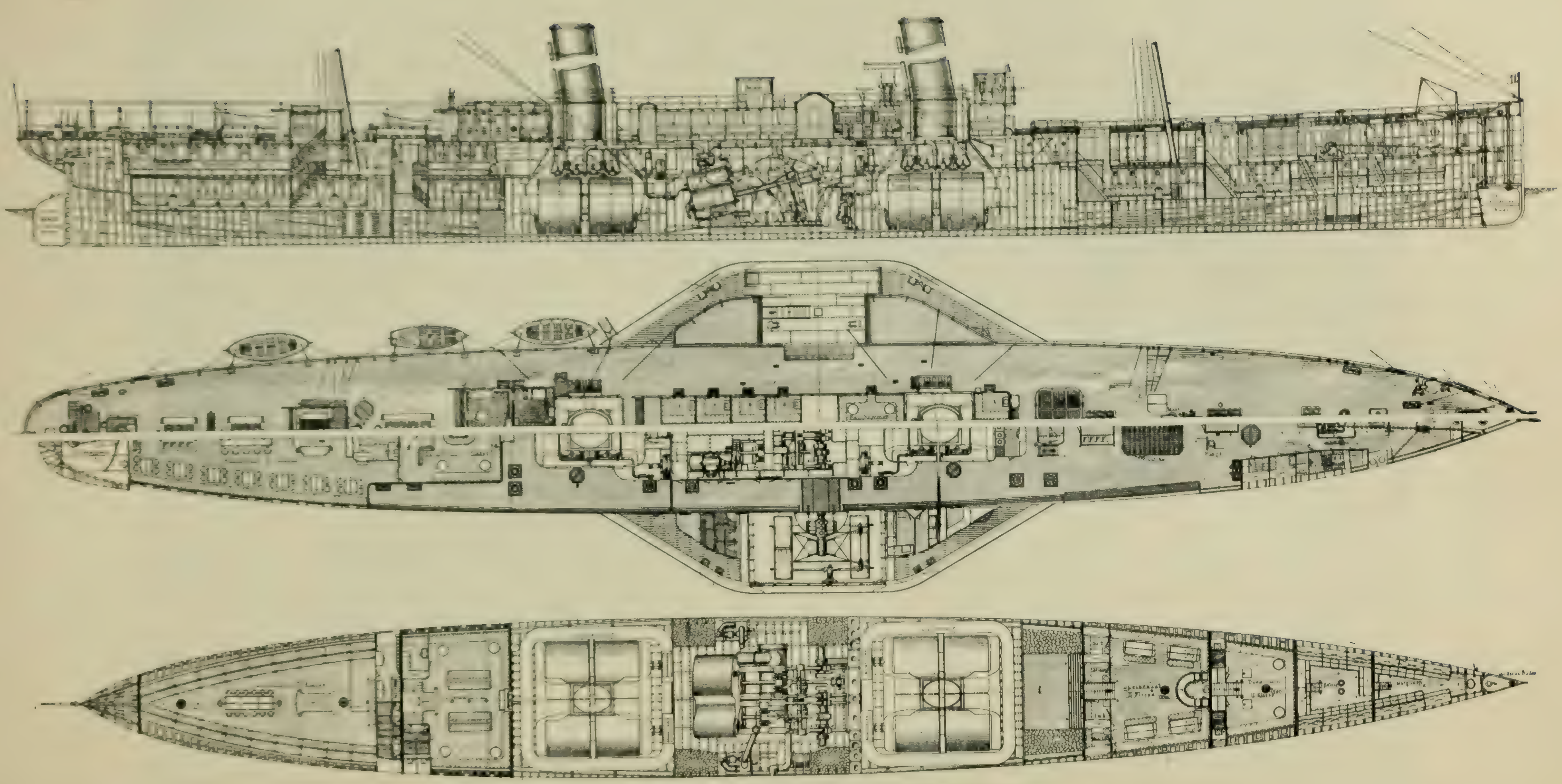
ties—wearing-apparel and the like—are dearer, and this largely by reason of the tariff. I do not purpose entering into the question of free trade against protection; a consideration of the direct influence on ship building is sufficient. It has been shown from official returns that only five or six per cent. of the workers in the United States profit by protection, and it stands to reason that all others are taxed to assist the industries in which these five or six per cent. are engaged. Thus if, as in a recent year, each inhabitant imports 50s. worth of goods each year, and pays 14s. of that sum in tariff rates, it means that £3 or £4 of the gross earnings of each head of a family of three or four go to support another industry. Thus, three-fourths of the price of some textile fabrics goes for tariff, and half of the price of cotton goods, while it may almost be said that the great metallurgical industries have no help; in fact, they no longer need it. The tax is indirect, but it is unequal in its incidence. No doubt some industries require fostering in the earlier stages; but since the civil war this help has been disproportionate to the need, and, as in 1816, an exhaustive inquiry is necessary to determine what industries are permanently established and have no need of protection, what industries are only partially established and might be fostered with help, and what industries help has failed to bring to a vigorous maturity. There is the story of the Senator grandfather who, inculcating economy, remarked that "it isn't what a man makes that makes him rich," and was met with the reply from the seven-year-old grandson: "Oh, no, it is getting a prohibitive tariff put on."

Of course, a relief in tariff rates would increase the value of wages, and so improve the condition of the worker, and therefore his work. The American ship builder may get his material more cheaply than his competitor in Britain, pig iron being 10 to 15 per cent., and steel nearly 20 per cent., less in the United States than in Britain. The equability of temperature in Britain and the cheap sea transport are in her favour: but a cheapening of clothing, if not of all other household effects, may nullify the former, and the railway freight from the mines is marvellously low. There is just the possibility, too, of a lower rate of wage, owing to the influx of workers and the immunity from trade-union interference; but these cannot be reckoned on with any certainty in favour of United States possibilities.

As to the need of assisting shipping, it is more difficult to write without being swayed by the success in Britain where no such help has been given. In the United States there are millions who have never seen the sea; they have no love for it. The enormous area of the country can satisfy any desire for migratory adventure; its varied climates, its gold fields, its prairies, its free life, generally provide



THE NORTH-GERMAN-LLOYD STEAMSHIP "KAISER WILHELM DER GROSSE," IN DRY DOCK.
Built by the Vulcan Company, Stettin, Prussia. 625x66x43 feet; 14,350 tons; 27,000 i. h. p.; speed, 22 knots.



THE BELGIAN MAIL STEAMER "MARIE HENRIETTE."

Built by the Société Anonyme John Cockerill, Seraing, Belgium. Length between perpendiculars, 340 ft.; breadth over paddle boxes, 76 ft. 7 in.; depth over the keel to main deck, 15 ft.; mean i. h. p. 8,000; mean speed on official trials, 22.2 knots.

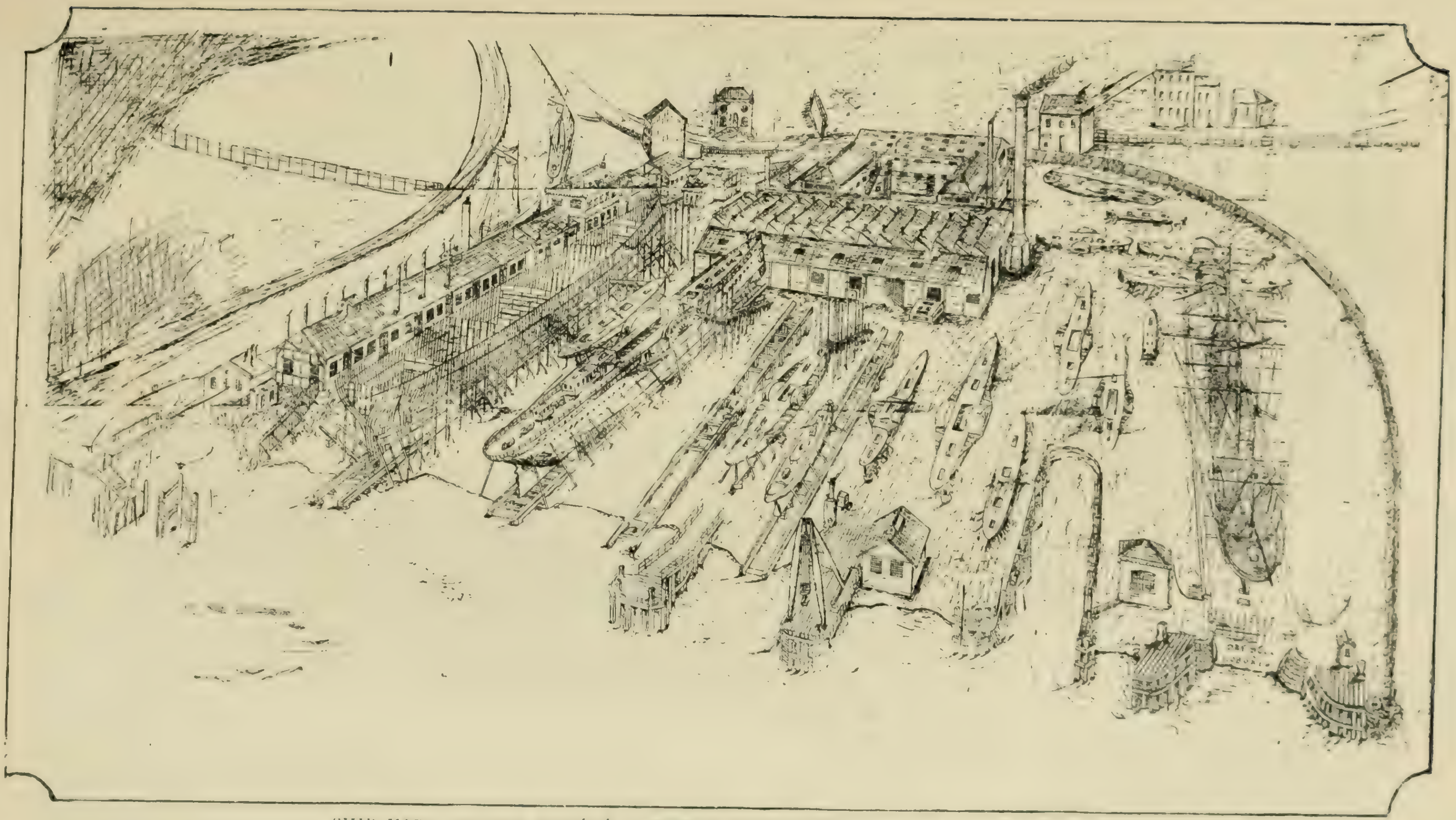
change enough in pursuits, whereas "the sea is England's glory," in very truth. In England, to ship before the mast was, if it is not still, the ambition of every wayward youth ; if he seeks the gold diggings, it is as an after-thought. Thus there is difficulty in awakening American interest and of finding American sailors, but there is no reason why the Scandinavian should not as readily sail under the Stars and Stripes as under the Union Jack. But there must be freedom of choice and of other conditions, as in Britain. The United States have trade for a fleet, but the financier lacks courage to enter heroically into the trade and give the builder sufficiently frequent orders to warrant experienced management and staffs, thus assuring as economical production as that which prevails in Britain. It is really more a question of removing disabilities than of providing subsidies for ordinary merchant steamers. Of course, I do not include mail contracts in the term "subsidy." The British owner has had to fight for economy, because he had no subsidy : the biggest lines—the British India, for instance—have not even the help of a mail contract, and in no country in Europe have subsidies created a general fleet comparable with that of Britain.

With the United States the task of the future is the more difficult (although not impossible), because it is largely creative ; with Britain it is only the retention of a trade still flourishing courageously, but threatened on all sides. The question in Britain is whether, without materially increasing wages, she can secure such an assimilation of conditions as to give her the same producing capacity that the United States enjoy. On that will depend the future relative position of the two countries. The idiosyncracy of the worker is an important factor. In the United States, especially after the war, wages were kept at a high and artificial level. Workers were few at the inception of industries, and thus the reward of labour-saving appliances to the capitalist was encouraging. All ingenuity was diverted into this channel, especially in the case of small productions,—*i. e.*, sewing machines and the like,—in some cases at the expense of the development of mineral, metal, and heavier engineering industries. The early worker readily accepted the conditions. He saw no reason against working two or three machines for all they were worth, provided his wages were satisfactory ; and even now that is the practice. Rightly so, too, for the purchasing power of wages rises with the increase in the productiveness of labour, provided prohibitive tariff does not vitiate economic conditions. The Ricardian theory of man being unable to wear four coats simply because they now cost only a fourth as much has long since been exploded by the circumstance that, if he wears only two, he can in other directions add to his comfort, and so disburse his wage and create still greater need for labour. Thus in the United States the employer has no difficulty in inducing the worker to produce the maximum. I have heard of cases where, if the worker augmented a given high rate of production, he would secure a *pro rata* addition to the standard rate of piece-work.

In Britain, on the other hand, everything was originally done by hand. The prospect of lack of employment obscured the vision of the worker, and even now, after the lapse of thirty years and more, he has not quite acquired the lesson that cheapened production decreases the selling price to such an extent as ultimately to increase the demand and the need for producers. Men refuse to do their best at piece-work, lest the rates be reduced or the unemployed list be increased, and thus the most is not made out of the plant. The employers, again, may introduce the most ingenious of tools,—many from America, for instance,—but in the British ship-building yard or engineering works, where many are installed, the work done is 20 to 30 per cent. less than with identical tools in the United States. Moreover, in some cases two such machines may be tended by one man in the United States,—perhaps only an unskilled labourer,—while the trade-union leader in England demands that each shall be attended by one experienced tradesman, and that the production shall be limited.

Under conditions like these, a comparison of mere rates of pay conveys inaccurate ideas, for the United States machinery attendant, for, a daily wage, say, 50 per cent. higher than that of the British mechanic, may produce 180 per cent. more work. It is but a high testimony to Britain's repute and to the practical experience of management and worker that she has so long maintained her supremacy. There must be a limit, and the difficulty is to determine when it is reached. The policy of improving the condition of the worker has been satisfactory in the past. In the savings bank there is now for each inhabitant fully four times what there was sixty years ago, while at the same time only 80 per cent. of the population live in houses rated at less than £20 a year; fifty years ago there were 93 per cent. so situated. As to education, 33 per cent. of the couples married sixty years ago could not sign the marriage certificate, whereas now barely 7 per cent. are so illiterate. As to the supersession of hand workers by machines, no more significant proof to the contrary can be found than the fact that, whereas ten years ago only 34.8 per cent. of the population were engaged in factories, now 53.7 per cent. are so employed.

Britain has marched forward in superiority by reason of the individual experience of her workers; but they are becoming scattered



SHIP YARD OF THE SOCIÉTÉ ANONYME JOHN COCKERILL, SERAING, BELGIUM.

over the world. I have heard Mr. Cramp say that many of his Scotch and English workers were driven from home by the unscrupulous exactions of trade unionism. It is not generally known that most of the unions accept members who pay a smaller contribution than the full-paying member, receiving in return nothing, or practically nothing, but the right to work, or freedom from what is now known as boycotting,—a system which, if applied by the masters, might be called by a very hard name. These exiles, so to speak, soon disseminate the principles of British workmanship, especially as they soon reach the status of leading hands. And in any case other countries are now experiencing the success of failure well analysed. Almost every country yields proof of attainment of this stage. France has built the channel twin-screw steamers Tamise and Seine, running between Newhaven and Dieppe with efficiency equal to that of the Clyde-built Sussex, and is now building high-speed paddle steamers for the Dover and Calais mail service with engines of 7,000 i. h. p., to give 21½ knots speed in order to beat Clyde boats running there. Belgium has built the Marie Henriette and the Rapide, 22-knot paddle steamers running between Dover and Ostend as regularly as do the British ships Princesse Henrietta and Leopold II. Holland seeks to exert her influence on the Queenborough and Flushing route, and Germany has shown her skill with Atlantic, Australian, and China traders, and has produced the Kaiser Wilhelm der Grosse, the fastest ship in the Atlantic service, for which service Germany has twelve large steamers in process of construction. The United States have shown their skill in the St. Paul and St. Louis, so that it is too late in the day to think that British supremacy is unassailable. British merchantmen have led the way in speed and other sea-going qualities, though the navy has been quickly brought into line. In all other countries the navy has assisted materially in the education of the artisan.

The worker, when disputes arise, is too apt to impute selfishness to the employer. I have tried to show, rather, that the fate of a great national industry is in the balance. One thing seems clear; Britain cannot afford to increase the cost of production, since other countries are overtaking her in excellence and economy. A reduction in the hours of labour or in the rate of wage must be compensated for by an increased rate of production. There is no alternative, except it be the contemplation of the saying: "Times change, and we change with them."

THE CONSTRUCTION OF SLOW-BURNING BUILDINGS.

By Francis C. Moore.

FIRE protection, or fire-proof construction, so far as it relates to warehouse or office-buildings, has been the subject of much study and experiment, and the center of active discussion and thought. It is, therefore, rather strange that comparatively little attention appears to have been directed to the extension of the same principles to the buildings which, in the end, touch us all more closely. It is safe to say that to the average reputable citizen no place is so constantly the object of his thought and care as his home. It is the shelter of his family, and is the spot in which he himself finds comfort and rest. In earlier days he was obliged to barricade it against human enemies, while to-day he needs to protect it only against rain, snow, wind, and fire. The latter is his most dangerous enemy. It is liable to attack him in any one of the twenty-four hours, but most liable to turn him out of house and home in the middle of the night and in the middle of the winter, when the weather is coldest and when he is unconscious in sleep. He may well be thankful to any who will give him a hint as to how to ward off danger, and it is doubtful if he can look for valuable suggestions to any of his fellow-citizens with such assurance as to those who are engaged as underwriters in insuring against loss by fire, or as firemen in extinguishing fires, and who have, by reason of their callings, the largest experience, and, therefore, the greatest knowledge, as to how to construct dwellings with a minimum of fire hazard.

It is possible, of course, by the exclusive use of iron and brick, to construct a dwelling so that its owner may sleep complacently, without anxiety as to fire; but such construction is expensive, and there are few fire-proof houses outside of the largest and wealthiest cities. The majority of dwelling-houses in the United States, by reason of the relative cheapness of lumber as compared with masonry, are of wood. Probably the dwellings of Europe are built so largely of masonry because wood is expensive, and safer construction is an economic necessity. "For lack of wood the fire goeth out," but sometimes, even in Europe, not before it has wrought immense damage. While this article, therefore, is addressed especially to American practice, the principles and methods advanced are applicable on both sides of the Atlantic. If the writer, therefore, claims—and he does so claim—that it is possible to construct a dwelling-house of wood throughout in the most economical manner, and yet by such methods as will probably prevent its taking fire, or, in case of ignition, will so retard the progress of the flames as to admit of the escape of the inmates, if not, indeed, of the extinction of the fire without their being driven out of the building, he ought to find willing readers.

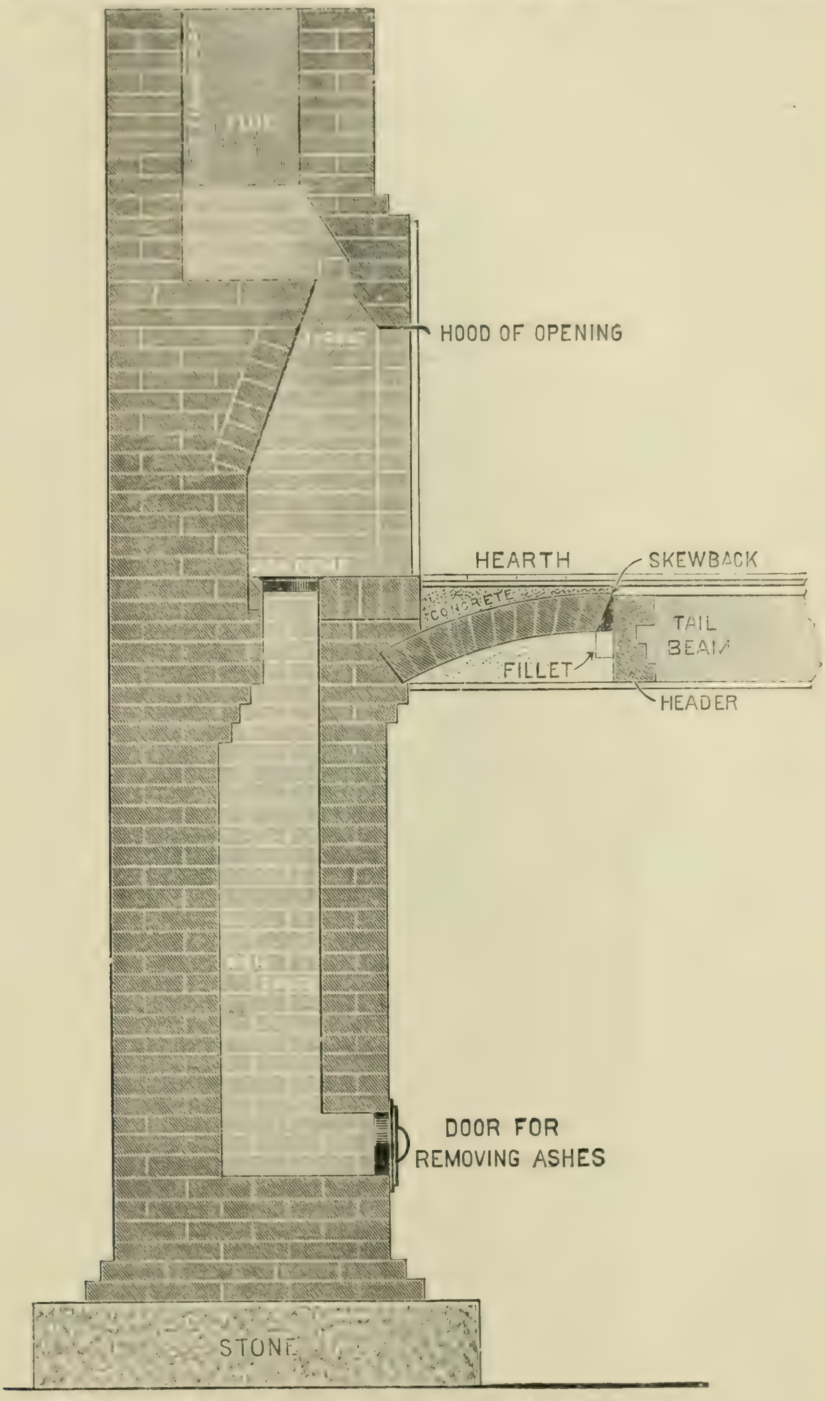
PREVENTION OF FIRES.

Flues. In nothing is the adage "an ounce of prevention is worth a pound of cure" more true than in dealing with fire. Fortunately the precautions necessary to prevent fires are inexpensive, and quite within the means of any one who builds a home, for he can make his dwelling secure for less than he usually expends in unnecessary ornamentation. The main thing to be observed is the proper construction of chimneys, fireplaces, furnaces, etc. Probably eighty per cent. of the flues in dwellings throughout the United States are unsafe, being only four inches, or half a brick, thick. Where the walls surrounding a smoke flue are less than eight inches thick, they should be lined with burned-clay flue lining. Ordinary, well-burned drain pipe makes good flue linings, although it is best to use linings manufactured especially for the purpose. I advise lining all flues, however,—even those having eight inches of enclosing brickwork. Where the chimney comes next to the weather, the eight inches will be worth all it costs in improving the draft of the flue, which would otherwise be chilled and result in a smoking fireplace. The flue lining, also, improves the draft, and—what is more important—insures something that cannot always be counted upon at the hands of masons—a flue for the full uniform size stipulated in the specifications.

No floor timbers or other woodwork should come within eight inches of the inside of any smoke flue, or within two inches of the outside of such flue. It is, however, customary for carpenters, in fastening their work, to drive wooden plugs, or wedges, into the joints of the brickwork. Where the enclosing wall is only four inches in thickness, there can be but one result. The statistics of fires show that more than twenty per cent. of those occurring in the United States each year are due to defective flues. This means a loss of more than twenty millions of dollars annually, and an inexcusable drain upon the prosperity of the country ; for, although insurance companies pay a large percentage of the property loss, they must, in turn, recoup themselves by higher rates of premium collected from property owners, so it is equally a loss to the country.

Hearths. All hearths to fireplaces should be supported by what are called "trimmer arches" of brick, illustrated in the accompanying diagram.

These arches rest at one end on the brickwork of the chimney, the other abutment being on what is known as a "header" beam



SECTION OF A PROPERLY BUILT HEARTH AND CHIMNEY.

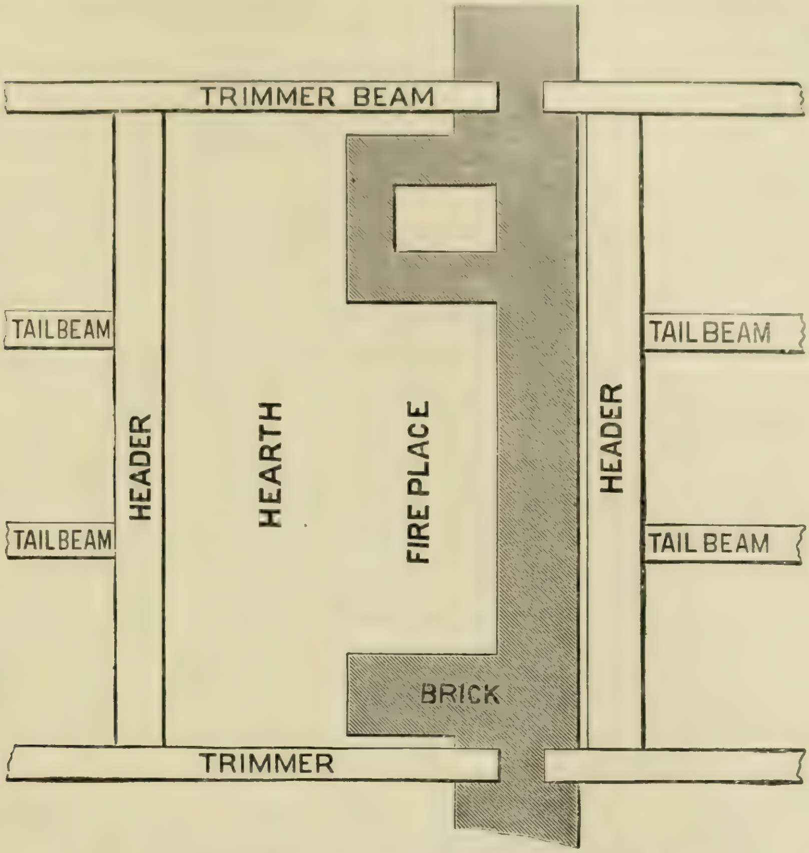
(also shown in the illustration), so that the hearth does not in any case rest upon wooden beams. This simple, but important, precaution is frequently neglected, and the most reprehensible carelessness amounting to criminal indifference to the safety of human life, is to be observed in many of our most expensive dwelling-houses. In one case coming to my notice, after the extinguishing of a fire in a costly dwelling, it was found that not only did the hearth of a fireplace rest upon the wooden floor beams, which had been carried under it, but the builder had actually swept the shavings and wooden rubbish into the space beneath the hearth, before laying the tile.

While on the subject of hearths and flues, it may be well to note that the illustration shows what a chimney should be, and to say that the shape of the fireplace, the inclination forward of the brickwork of the back, the contraction of the throat, and the square shelf observed in the drawing are all necessary to insure a good draft and to prevent that most disagreeable feature of a home—a "smoky" chimney.

It will be observed that an ash dump has been provided, and an ash chute. This costs nothing, and a person building can just as well secure it without extra expense, the bricks saved more than offsetting the labor of arranging the chute.

All chimneys should be built from the ground. Under no circumstances should they rest, as they frequently do, upon floor beams; and the framework of the building should be trimmed clear of them, so as to allow them to settle without opening cracks or joints. Especially is this precaution necessary where the chimney passes through the roof. At this point it is sometimes customary to enlarge the chimney so as to form an overhang or projection. The shoulder so formed is almost certain to cause a fracture in the chimney at the most dangerous of all points, in consequence of the brickwork settling faster than the woodwork of the dwelling.

All floor-timbers should be "trimmed" clear of the hearths and brickwork of the chimney, so as not to be in contact with it at any point. This is easily secured by what are known as "header"-beams, carried in front of the fireplace and at least twenty inches from the chimney-breast, supported by the "trimmer"-beams, which enter the wall on each side of the chimney. These should be at least four inches from the side of the chimney. The intervening "tail"-beams, as they are called, are mortised into the header. Where more than three tail-beams are framed into the header, however, it should be supported in "stirrup"-irons (sometimes called "bridle"-irons), by which the weight is carried on the trimmer-beams without mortising into them by "tenon-and-tusk" joints, which sacrifice material and carrying capacity. In this way the floor-beams are free of contact with chimney-flues. The building law of New York city requires (what should not in any case be neglected) that all hearths shall be laid on trimmer-arches of brick carried across from the chimney-breast to the header-beam already described, so that the hearth shall not rest upon or near wooden beams in any case. This whole matter is more fully explained by the accompanying illustrations :

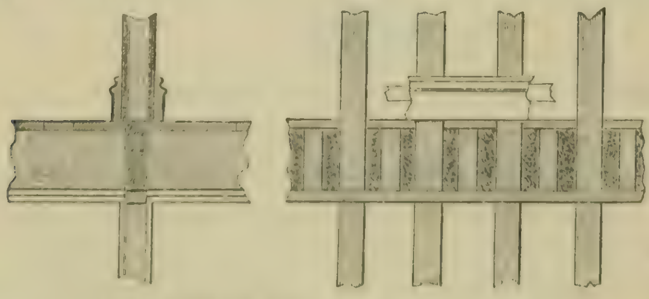


FIRE PLACE SHOWING HEADER, TRIMMER AND TAIL BEAMS.

Furnaces. These are fruitful sources of fires. They are generally provided with wooden cold-air boxes. The result is that a back draft from the furnace will cause a fire; also, dried leaves or other rubbish blown in from the outside are apt to ignite. Metal cold-air boxes should in all cases be provided. They cost more money, but they insure the house, as well as the health of the inmates. Wooden boxes open joints or seasoning cracks, and take the dangerous air of the cellar from wet coal, decaying vegetables, etc., sending it throughout the living rooms of the house, whereas a galvanized-iron cold-air box insures pure air from the outside. In this respect alone air-tight metal cold-air boxes are worth many times their extra cost.

Furnace Hot-Air Flues. These, where they pass between floors or wooden partitions, should be double, with an inner and outer pipe, separated by an air-space of, say, half an inch. It is well to stipulate, also, that the wooden studs in partitions shall be covered with bright tin, and an additional precaution, and one which will insure safety, is to fill the space in the partition around the pipe with gauged mortar,—that is, mortar mixed with plaster of Paris to insure hardness. Wooden lathings should not be used across the joists between which hot-air flues pass; in all cases metal lathing should be employed.

Fire-Stops in Hollow Partitions, etc. Having considered precautions which tend to prevent fires from starting, it is next in importance to prevent them from spreading. Unfortunately most American structures are built upon plans which seem to insure the rapid progress of flame from the starting-point to the roof. The enclosing walls of frame buildings, and all of the partitions which divide the rooms and hallways, are hollow; between every pair of studs, or joists, is a flue with a wooden lining of lath and plaster, in which fire secures an easy passage. It is very easy to correct this fault, it being necessary only to fill in at each floor all spaces which lead to the floors above with incombustible material, to stop a draft. Probably the best material is bricks and mortar, filled in to a height of about a foot, although mineral wool and other like substances may be employed. Even a few shovelfuls of mortar would, under ordinary circumstances, be sufficient. The accompanying illustration shows how this may be done. It is possible in this way to insure such slowness of burning as will enable the inmates to escape with their lives or, better still, to extinguish the fire itself and save the structure with its contents.



FIRE STOPS IN FLOORS AND PARTITIONS.

Probably not two per cent. of the dwellings of the United States have been erected with regard to this simple, but inexpensive, precaution. That thousands of lives are not lost annually is due to the fact that fires seldom start in dwelling-houses, rather than to proper precautions in construction. Even as it is, the mortality list is serious, and sufficiently large to justify the most stringent laws as to the construction of dwellings and careful official inspection of them while in process.

Buildings the enclosing walls of which are of brick or stone are usually furred off for plastering,—that is, wooden strips are nailed against the wall, to which the plastering laths are in turn nailed, to receive the plaster. This leaves an air-space of about an inch and a half, through which flame finds ready progress to the upper levels of the building, working insidiously where it cannot be seen. The New York building law requires that in all furred walls the course of brick above the underside and below the top of each tier of floor beams shall project the thickness of the furring, to more effectually prevent the spread of fire,—a most important and inexpensive precaution.

The following specifications would provide, in any contract for building, the various precautions I have suggested :

SPECIFICATIONS.

Chimneys and Flues. The chimneys shall be carried up, as per drawings, from the ground. Above the roof black cement mortar shall be used, and all smoke flues shall be surrounded with eight inches of good brickwork, and shall be lined on the inside with a burned clay or terra-cotta flue-lining, from the bottom of the flue or from the throat of each fireplace continuously to the extreme height of the flue. The ends of such lining-pipe shall be made to fit close together, and the pipe shall be built in as the flue or flues are carried up. All flues for fireplaces shall be of a capacity 8″ × 12″, and the furnace- and range-flues shall also be 8″ × 12″ inside capacity. (NOTE.—If 8″ × 8″ flues be desired, so specify.)

All flues which are not lined shall have struck joints ; no parging or plastering will be allowed on the inside of any flue.

Fireplaces. Here limit height of fireplace—I advise 25 inches. The back of all fireplaces shall be inclined toward the front, beginning six courses of brick from the floor of the hearth, as per drawings (see diagram), to secure a good draft, and the fireplaces shall be lined with firebrick, laid with close rubbed joints (or with cast-iron fireplace-lining, as per design and pattern specified, if cast-iron is preferred). The front opening of all fireplaces shall be supported by two iron bars ½″ × 2″, nine inches longer than the width of the opening, and shall be fitted with automatic ash dump grate. This to be furnished by mantel-man.

Furnish and set proper iron thimble in furnace-flue.

The tops of all chimneys shall be laid in black cement mortar, and shall be capped with a 3-inch capstone, and the openings in the capstone shall correspond in size with the dimension of each flue, so that no shoulder or other projection will extend over the opening.

No chimney shall be enlarged where it passes the roof to form any overhang or projection over the roof.

The chimney walls from the cellar to first floor shall be carried up to form ash pits, securely inclosed with brickwork, these to have 12″ × 16″ iron doors, with frame, in cellar, to be built in during construction. This contractor to furnish said iron doors and ash dump.

No chimney shall be started or built upon any floor or beam of wood, and in no case shall a chimney be corbeled out more than eight inches from the wall, and in all such cases the corbeling shall consist of at least five courses of brick.

All hearths shall be constructed with trimmer-arches extending twenty inches from the chimney-breast to a "skew back," or wedge-shaped piece of wood spiked to the header-beam, and the top of the arch is to be filled with two inches of concrete to the top of finish floor.

The header-beam shall rest securely in stirrup-irons to be furnished by carpenter, and there shall be no wooden lath or furring on the chimney-breast.

It will be observed, in the illustration on page 957, that the trimmer-arch abuts upon a wooden skew back, or wedge of wood securely spiked to the header-beam. The skew back is, in turn, supported by a fillet of wood spiked to the beam. This is necessary to secure a proper arch. If the footing of the arch comes squarely against the wooden header-beam, the shrinkage of the latter will in time release the arch, and allow it to fall. It is unfortunately, however, the practice not only to omit this skew back, but to omit the trimmer-arch altogether, and to support the hearth directly upon the floor-joists. This is a most dangerous construction, and a fire is only a question of time. It seems incomprehensible that an honest builder having any decent regard for safety to life would build in this way; yet fires from this cause are frequent.

FURNACE HOT-AIR PIPES, ETC.

All hot-air pipes shall be provided with a damper or valve at the furnace, and shall be of the sizes specified. The principal register shall be fastened open, so that it cannot be closed. The heating-pipes throughout the house to the various registers are to be constructed of the best (one cross) tin, and, wherever they pass between floors or other hollow partions, are to be made double, with an air space of ½ inch between the inner and outer pipe. The wood studs nearest the pipe shall be lined wlth bright tin with air-space. The lathing from stud to stud on both sides between which the pipes pass is to be of metal, and no hot-air pipe shall be nearer than three inches to any wooden studs; and this contractor shall notify the carpenter as to studs between which hot-air pipes are to pass, to secure requisite separation. This contractor is to furnish said metal lathing and attach the same; and any hot-air pipe entering a wooden partition, or passing between a wooden floor and the ceiling below, within ten feet of the furnace shall be made double, and shall be wrapped with ¼-inch asbestos board to a point fifteen feet distant from such furnace.

This contractor is also to furnish a cold-air box of 24 B B gage, galvanized iron of the best workmanship, double-seamed and well braced, fitted with regulating damper so secured that the cold air cannot be cut off by negligence or otherwise, the outer opening to be protected with wire netting; and the inlet for cold air shall be so arranged as to supply an adequate amount of air to the hot-air chamber of the furnace, and shall be at the top of the furnace between the cover of the hot-air chamber and the cover of the furnace, in order to prevent the overheating of the furnace cover near the ceiling or woodwork.

This contractor is to furnish also a metal shield of galvanized iron one inch larger in diameter than the top of the furnace, and suspend the same from the ceiling above the furnace so as to leave an air-space between the shield and the ceiling.

FIRE–STOPS.

Beam-filling. This contractor shall beam-fill all exterior walls between the beams with bricks laid in lime mortar to their top level, same thickness as wall.

Fire-stops. This contractor shall provide fire-stops at each story in all hollow walls and hollow partitions. He shall fill in solid between all upright studs or timbers to the depth of the floor-beams with suitable incombustible materials, using, wherever possible, bricks and lime mortar for the purpose. Where it is impossible for any reason to use bricks and mortar, he shall use sheet tin, which shall be carefully and closely nailed to prevent the passage of flame.

In all furred brick walls the course of brick above the under side and below the top of each tier of floor-beams shall project the thickness of the furring, to more effectually prevent the spread of fire.

BRITISH RAILWAY FARES AND THEIR INFLUENCE ON TRAFFIC.

By William J. Stevens.

IN making any comparison of British and American railroad fares two important points must be kept steadily in view. The first is that the average journey in Great Britain is perforce much shorter than in America, and that the restrictions naturally imposed on the length of the journey by the geography of the country are enhanced by the enormous local traffic built up around the large towns, and more particularly in and around London. This traffic has grown enormously, and, whereas in America it is to a large extent catered for by the street-railroad companies, in the large towns of England the major part of it finds its way to the railways. That important class of traffic we will consider more in detail later, passing on to the second vital point of difference between the fares of the two countries, which arises from the fact that, whereas in Great Britain the uniform demand is for safety, speed, comfort, and seclusion on the comparatively short journeys undertaken, in America, while the standards of safety, comfort, and speed show greater variation, the demand for seclusion is practically non-existent. Hence the classes, as we have them in Great Britain, have no counterpart in America.

The average length of the journey on the railways in Great Britain may be estimated at about 9 miles. No official data on this subject are available, but for the year 1896 the average sum received per passenger of all classes, excepting season ticket holders, was 7.34 pence. This figure is diminishing, as a comparison with the average receipt per passenger ten years ago will show. This comparison is afforded below:

1887.

Total receipts (excluding season and periodical tickets)	£24,163,355
Number of passengers " " "	733,678,531
Average receipt per passenger	7.89 pence.

1896.

Total receipts (excluding season and periodical tickets)	£29,971,578
Number of passengers, " " "	980,339,433
Average receipt per passenger	7.34 pence.

From 1887 to 1896 the decline in the average amount of revenue per passenger was .55 of a penny, which, for the 980,000,000 carried in 1896, represents £2,246,611. This decline may be, and probably is, partly attributable to a shortening of the average distance travelled, but it is also due to a considerable extent to declining fares. British railways do not, unfortunately, supply the figures necessary to test this accurately, for they do not give the number of passengers carried one mile, just as in the case of freight traffic they do not indicate the ton-mileage.

In the United States the average receipt per passenger per mile and the average amount paid per passenger, according to "Poor's Railroad Manual," have been as follows from 1884 to 1896 inclusive:

YEAR.	Average receipt per passenger per mile. Cents.	Average receipt per pas'ger Cents.
1884	2.356	61.87
1885	2.199	57.16
1886	2.194	55.43
1887	2.276	56.17
1888	2.246	55.68
1889	2.169	52.44
1890	2.174	52.13
1891	2.184	52.30
1892	2.168	50.99
1893	2.072	52.00
1894	2.025	48.34
1895	2.069	49.25
1896	2.034	49.58

During recent years the average rate per mile has certainly diminished very much, according to the above figures, but the fact that from 1872 to 1896 rate-cutting was very prevalent in the United States probably accounts for this, to some extent at least. Anyway, the average charge per passenger is distinctly more than 2 cents per mile. The average distance travelled per passenger is given by the same authority as follows:

Year.	Average distance travelled per passenger. Miles.	Year.	Average distance travelled per passenger. Miles.
1884	26.24	1889	24.18
1885	25.99	1890	24.05
1886	25.27	1891	23.95
1887	24.68	1892	23.59
1888	24.79	1896	24.38

The average distance travelled is thus about 24½ miles, as compared with 9 miles in Great Britain.

As regards the average charge per mile, there does not appear to be much to choose between American and British railways. In Great

Britain the fares are regulated to a large extent by the law, but the companies, in their own interests, go far beyond the obligations thus imposed upon them in their concessions to the public. In fact, even during the last ten years the policy of cheap fares has found many recruits among the managers of British railways, the tendency thereto having received much encouragement from the successful results of lines which had already boldly launched forth in that direction. The result has been an enormous development of the third-class traffic, representing the lowest scale of fares. This is the outcome of the extended facilities given to that class. Originally the first- and second class passengers secured, in return for their higher fares, not only a better class of carriage, but the right to travel by express trains. But now the ordinary third-class passenger enjoys the right of travelling by all trains, the exceptions to this being practically confined to a few trains to Brighton. In addition, the difference in the accommodation afforded to the three classes has lessened considerably, and in the process the third-class passenger has secured the largest benefits. In fact, the results of this encouragement of third-class traffic have been so successful as to seriously jeopardize the intermediate class, so that, while many companies, anticipating events, have already abolished it, others have largely reduced the second-class fares, in order to stimulate this traffic. In Scotland second-class is now non-existent, and in the case of several leading English lines (including the Great Eastern, Great Northern, and North Eastern), it is retained only for suburban traffic. In Ireland it flourishes, probably because the third-class accommodation there is, as a rule, much below the standard attained in other parts of the United Kingdom. The diversion of passenger traffic from the first and second classes to the third class may clearly be seen from the following comparison of the receipts for the United Kingdom from each class for the years 1887 and 1896:

	1887.		1896.	
CLASS.	Amount.	Per cent.	Amount.	Per cent.
First	£3,081,508	12.8	£3,133,149	10.5
Second	2,788,803	11.5	2,058,139	6.9
Third	18,293,044	75.7	24,780,290	82.6
Total	26,163,355	100.0	29,971,578	100.0

It will be observed that the third class traffic, even in the past ten years, has increased from 75.7 to 82.6 per cent. of the total passenger revenue. In fact, the whole of the increase in passenger receipts during the ten years has been in the third class, while, in addition, about £680,000 has been diverted from the superior classes to that denomination. In the second class the decline was preëminently large, and, in fact, would have been much larger but for the stimulus given by a number of companies to this traffic during 1896 by a large reduction in the second-class fares. In 1896 there was an increase of £123,000 over the 1896 figure in the amount received from second class—the first increase shown for many years. In the number of passengers the third class shows an even larger predominance than in receipts. In 1896 this class represented 888,500,000 passengers out of a total of 980,500,000—equal to 91 per cent.

There is no doubt whatever that the bulk of the third-class fares are under one penny a mile. In the first place, the companies are compelled to provide sufficient accommodation at fares not exceeding one penny per mile, and also proper and sufficient workmen's trains "at such fares as appear to the board of trade to be reasonable." In the second place, fares more than a penny per mile are subject to passenger duty of 2 per cent. for urban traffic, and 5 per cent. for other traffic. As early as 1872, however, a parliamentary committee of both houses reported as follows as to the expediency of special legislation encouraging third class traffic :

"The history of the traffic in third-class passengers affords a strong argument against attempting to foresee and provide for a want of this description by imposing general, permanent, and compulsory obligations on railway companies. It has been shown that parliament, anxious to protect the lower classes at any rate from the apprehended monopoly of railway companies, imposed special obligations on the companies, supposed to be in favour of these classes, and attached to these obligations a special exemption from railway taxation. It has also been shown that *railway companies, in their own interest, are now doing for third-class passengers more than parliament ever thought of requiring*; that third-class traffic is one of the *most growing sources of profit;* and that the present operation of the special legislation on the subject is to give a very questionable exemption from general railway taxation, to create confusion and litigation, and to give the companies inducements for withholding from third-class passengers facilities which they would otherwise afford." The above remarks, written in 1872, are infinitely more applicable in 1898,—twenty-six years after,—though the passenger traffic now is nearly 150 per cent. greater than it was then, so far as the number carried is concerned. Examples of concessions made by the companies to the public over and above their parliamentary obligations are easy to find. The reductions on return tickets (which are often much cheaper than two single tickets) ; half-price charged for children ; and no charge at all for infants,—are cases in point, for in none of the instances quoted are the companies legally bound to afford the privileges they do. Further, in complying with the legislative requirement as to workmen's trains, they have gone much beyond expectation, and in other matters have conceded privileges which they are not required to grant. As evidence that the fares less than a penny per mile are increasing, and that those more than that are diminishing, the amounts paid by the companies as government duty may be given. For the last ten years the amounts thus paid have been as follows:

Financial year of government ended March 31.	Amount of Railway Passenger Duty. £
1888	314,993
1889	311,506
1890	324,461
1891	324,117
1892	324,984
1893	310,325
1894	279,093
1895	260,694
1896	259,342
1897	272,183

It should be pointed out that the above figures include government duty paid on season tickets, a class of revenue which has been showing great expansion in the last ten years. Though the fares for the daily journey with these tickets are generally less than the ordinary third-class return fare, and well under the limit of a penny per mile, the government duty charged depends upon whether the ordinary single fare of *the same class* is or is not more than a penny per mile. As most of the season tickets are for the first and second classes (some companies making a rule to issue none for the third class), most of the revenue from this source is chargeable with duty, and the duty so paid is included in the above figures. For 1896–7 the duty paid under the 2-per-cent. scale for urban traffic was £31,647—equal to a gross amount of £1,582,350. For the same period the amount received under the 5-per cent. scale for other traffic was £240,500—equal to a gross amount of traffic chargeable of £4,810,000. Thus the total traffic (including that derived from season tickets) charged with duty was about £6,392,000. Of this sum £2,914,000 was the amount of receipts from season tickets, etc., and, allowing therefor, it is probable that the amount received by the railways in respect of fares more than a penny per mile was not more than £4,000,000 out of nearly £30,000,000 in all. During the ten years, in spite of the fact that season-ticket revenue has increased by nearly a million (or 50 per cent.), the amount of government duty paid has declined from £315,000 to £272,183, or nearly 14 per cent.

It would be unfair to judge English railways merely by the ordinary fares charged, for the concessions made in various directions are so important, and the traffic arising therefrom so large, that they cannot be omitted. Below is a brief summary of special tickets issued at reduced fares, ranging from less than a farthing to rather more than a penny per mile: tourists' tickets, excursion tickets, workmen's tickets, market tickets, week-end tickets, emigrants' tickets, volunteers' tickets, golfers' tickets, tickets for pleasure parties of not less than ten, tickets for soldiers, sailors, and police, privilege tickets for railway servants, commercial travellers' tickets.

The above list is by no means exhaustive, but it gives an idea of the extensive way in which traffic has been cultivated by judicious concessions to the public. Many of the above special rates represent single fares for the double journey, others a fare and a quarter, and the range extends to two-thirds and three-fourths of the ordinary fare. Privilege tickets for railway servants are issued at one-fourth of the ordinary first-class fares. Workmen's tickets are issued at unusually low rates, where the traffic is sufficiently large. Thus, the Great Eastern Company issues an immense number of these tickets to Liverpool Street at two pence for the return journey from points as far out as Enfield. The distance to that place and back is more than 21 miles, and the ordinary return fare 1s. 4d. These tickets carry, moreover, the privilege of alighting at, or returning from, any intermediate station. They are available only early in the morning on the outward journey, but can be used for return journeys after midday.

Tourists' tickets are issued from May to October inclusive, and are available for return at any date to the end of the year of issue. They always take the form of return tickets, and are issued only to seaside and other holiday resorts, but they represent a considerable saving on ordinary fares, as the following examples show:

London to	Ordinary Return Fare 3rd class s. d.	Tourist Fare 3rd class s. d.
Aberdeen	78. 9	56.0
Edinburgh	62. 8	50.0
Glasgow	62.11	52.0
Wick	106. 8	84.0

The tourists' tickets, besides, confer great freedom for breaking the journey, and even for going out of the direct route in certain cases;

for instance, passengers *via* Edinburgh may break their journey and proceed *via* Glasgow without extra payment. Tourists' tickets, and week-end tickets as well, are available for all trains.

Excursion tickets are now issued by all the leading companies at enormous reductions from ordinary fares, the extent of the reduction depending upon the interval allowed between dates of issue and return. The following are a few specimens of short-date and long-date excursion fares:

SHORT-DATE EXCURSIONS.

LONDON TO	Available for	Fare s. d.	Distance there and back. Miles.
Birmingham	1 day	5.0	226½
Liverpool	3 or 6 days	15.0	402
Manchester	1 or 3 days	10.0	378½
Blackpool	3 or 6 days	16.0	461
Derby	3 or 6 days	10.0	267½
Harwich	1 day	4.0	141
Brighton	1 "	3.0	102
Eastbourne	1 "	4.0	130
Hastings	1 "	4.0	152

LONG-DATE EXCURSIONS.

LONDON TO			
Keswick	16 days	25.0	598½
Llandudno	16 "	20.0	454½
Barmouth	16 "	20.0	514
Dublin	16 "	25.0	689
Belfast	16 "	25.0	585
Londonderry	16 "	30.0	891
Glasgow	16 "	25.0	804
Aberdeen	16 "	35.0	1081
Elgin	16 "	38.6	1241
Scarboro	16 "	20.0	509
Whitby	16 "	20.0	537
Yarmouth	16 "	15.0	243

The average fare is .37 of a penny for the short date and .43 of a penny for the long-date excursions—decidedly low rates of charge. Of course the excursion passengers have to travel by certain stated trains in most cases, though in the case of the long-distance excursions it is frequently an ordinary train that is specified. No luggage is allowed with excursion tickets, unless specially stated. On the other hand, each first-class ordinary ticket entitles the holder to take 120 pounds of luggage, each second-class ticket 100 pounds, and each third-class ticket 60 pounds without charge.

Reference has been made to the development of suburban business. It is an extraordinary fact that the two London underground railways last year carried 117,250,000 passengers, besides season-ticket holders, the average sum received from each passenger having been 2.016 pence. Another company,—the Great Eastern,—whose suburban traffic has gone up by leaps and bounds of late years, carried last year more than 96,500,000 passengers, besides season ticket holders. In 1888 it carried only 72,000,000, having thus shown an increase in only eight years of 24,500,000, or about 34 per cent. The season-ticket revenue of this company has also increased since 1885 from £163,777 to £259,358 for 1896, or by nearly 60 per cent. This stupendous suburban traffic has been built up by an enormous capital outlay on extensions of stations and widening of lines, while the good character acquired by the company for punctuality and cheap fares,—the direct consequence of able management—has contributed even more to produce this satisfactory result. The policy pursued not only has been to the public benefit, but has yielded the shareholders good results, as will be readily understood when it is stated that the dividends paid and the price of the ordinary stock of the Great Eastern were never higher than at present.

While the fares charged by English railway companies are undoubtedly tending towards a lower level, the *quid pro quo* received by the traveller is also increasing, so that the profit per passenger per mile is probably declining. But the growing cheapness and popularity of public travel are compensating the companies, so that more trains are run, and they are better filled. There is no doubt that the maintenance of these distinct classes on all trains has been, and continues to be, a great expense to those companies which still maintain them. The superior classes of carriages are often very scantily filled, or even empty, but they have to be run on all trains to meet possible requirements. The third-class carriages, on the other hand, are well filled. Thus the provision of the superior classes of accommodation involves an addition to the dead weight of the trains, for which the extra fares paid by the first- and second-class passengers certainly do not compensate. For this reason the companies whose second-class traffic had fallen off to the largest extent abolished it. The tendency is undoubtedly towards only one class,—the third,—though that eventuality appears remote. It is significant that the chairman of the Great Northern Railway—a company which has already abolished second-class except for London suburban traffic—lately made the following statement on this matter: "I confess I look with some doubt on the wisdom and policy of trying to assist any opposition to what is the evident trend of the public view as regards travel, and I certainly think the trend is rather in the direction of still further reducing the number of classes than increasing them. In other words, it would be easier for our traffic arrangements if we could have but one class and carry everybody, and so fill our carriages reasonably full, whereas we now carry a good many compartments which are by no means full.''

For many years competition in Great Britain has taken the form of extended facilities, especially to the third-class passenger, and this levelling-up has, together with declining fares, been the main incentive to the growth of the third-class traffic. Though first- and second-class fares have also declined, this movement has not been sufficiently strong to counteract the drain to the inferior class. It is generally recognized that, in proportion to the accommodation afforded, the third class is much the cheapest of the three, and the very fact that the superior classes of carriages are so scantily filled remains in many cases almost the only inducement to use them.

In regard to speed and safety the provision made for all classes of passengers in Great Britain is unequalled elsewhere in the world. The block telegraph system and interlocking of signals are universal, and the expenditure on the permanent way and rolling stock is most liberal. In the United States the same protective appliances and precautions are no doubt largely in existence, but they are by no means the rule. The obligations and restrictions under which the railways are placed by the law and government-supervision in the interests of safety are a burden on the railways, and those who attempt to prove that fares might be greatly reduced should bear this in mind. Public opinion on this matter has been educated to demand a high standard of safety, and the standard is rising with increasing cost to the railways. Considering the standard of comfort, safety, and speed afforded, on the average, by the railways of Great Britain, the fares bear comparison with those of any country. And, though various anomalies at present exist, the tendency is continually towards lower charges, combined with better accommodation in every respect—a policy which, while benefiting the public, is also yielding highly satisfactory results to the railways.

DEVELOPMENT OF MACHINERY FOR SHEET-METAL STAMPING.

By Oberlin Smith.

VERY many ages of nature's wonderful work in reproducing in a cheap way innumerable duplicate articles from the original germ or seed (which was not so cheap) were required as an example to conservative-minded mankind and womankind before they took a hint, and commenced to get the things they wanted cheaply and easily by causing the original pattern, or model, upon which great thought and expense were lavished, to reproduce its kind automatically.

One of the most notable examples of this great factor in any advancing civilization was undoubtedly the invention of the art of printing, whereby an elaborately-prepared engraved plate, or font of type, containing as it were much of the stored-up talent and brain-power of the artist who produced it, is endowed with the wonderful principle of indefinite multiplication.

After the art of printing, a new development of machinery for manufacturing processes commenced, but up to the middle of this century had not gone much farther, so far as metal-work was concerned, than the use of engine-lathes, planers, and drilling-machines for various paring processes, and the cutting and perforating of bars and sheets as representative of *shearing* processes. In the original form of these machines the reproducing principle was not manifested in any great degree, but it began to appear more particularly in the milling-machine, in which special-shaped cutters duplicated surfaces very many times before wearing out.

Later commenced the wonderful mechanical development, chiefly American, of the last few decades, in applications of the duplicating principle to numerous articles used in daily life, but more especially to such things as guns, sewing-machines, type-writers, mowing-machines, etc., which never could have developed into their present extensive use, had not the means also been developed for manufacturing cheaply. The most conspicuous instances of interchangeability of duplicate parts, with consequent cheapness and efficiency, were undoubtedly those of the turret-lathe and of jig-drilling. In its more comprehensive sense, the latter includes the use of cradles, jigs, and other guiding tools for various processes beside drilling proper, and it should be said that essential to all the work in question was the art of accurate gauge-making for the testing of the desired duplicate pieces and for the proper adjustment of the machines engaged in producing the same.

Later, and ministering in a still greater degree to the duplication of cheap pieces, came the art of press-working. Indeed, it may be said that many of the processes involved therein are more nearly akin to those used in printing than are any of the operations employed in the machine-work referred to. In witness of this, we have some embossing and coining operations which are almost identical with those performed by certain printing presses.

Within a very few years past the art of press-working metals has developed to a phenomenal degree, by reason of modifications which enable them to be applied in the production of many articles, or parts of articles, which until recently were made by the older and far more expensive methods of casting and forging.

In general, the processes in question may be roughly classified as *cutting*, in which are included punching and shearing; *forming*, including bending, embossing, and curling; *drawing* and re-drawing, which are more than forming, inasmuch as the metal is subjected to an extensive distortion or molecular flow, incident to the changing of a flat annular disc into a cylindrical, or conical, or approximately hemispherical, form of smaller average diameter, its surfaces being meanwhile rigidly confined to prevent wrinkling; and, lastly, *coining*, with which should be included drop-forging, the metal in both cases being treated as a liquid and simply pumped, as it were, into the shape desired, the molecular flow being very great, and the whole object being treated as is a pat of butter or a cake of soap in the molds provided for its new incarnation.

Among the numerous producing establishments extensively using the tools in question are those which make household- and kitchen-utensils, and various other tinware; brass-working shops; factories devoted to lamps and lanterns; clock and watch makers; silverware and jewelry manufacturers; railroad shops; bridge and girder mills; hardware and lock factories; canners of fruits, vegetables, fish, and meats; government mints; petroleum refineries; paint and varnish manufacturers; stove makers; the producers of agricultural implements; trunk makers; toy makers; zinc and copper workers; producers of wines and medicines; musical instrument manufacturers; and many of those who fashion articles in paper, cloth, leather, and soap, as well as in the various metals.

After ordinary shearing or punching, and also coin- and medal-making, the earliest extensive commercial adaptation of press-working was, probably, to the production of kitchen utensils. These, as is well known, are now produced seamlessly, from flat sheets, by the drawing process, so that excellent utensils can be bought at the cheap stores which far surpass in beauty and cleanliness the vastly more expensive ones formerly soldered from numerous pieces. This process seems to have originated in France, and is now many years old, but the more recent development in metal stampings appears in the line of working cold steel into numerous complicated forms to replace castings and forgings.

In the pictures about to be described, attempt has been made to give examples of only a few of the articles referred to; in fact, not all the general classes of processes are included. Some of the stamped work shown, however, is sufficiently unique, at any rate to non-mechanical readers, to be worthy of the notice given it.

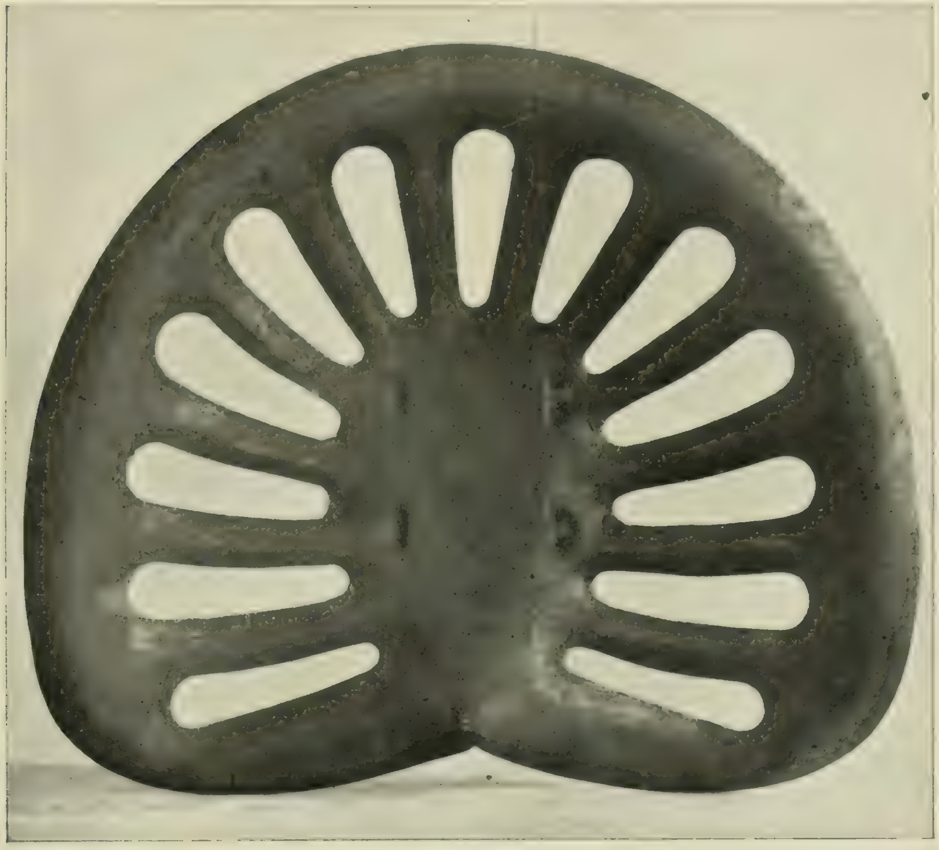


FIG. 1.

Pertaining to agriculture: Fig. 1 shows a mowing-machine-seat, made at two operations from cold steel, which is very much stronger, lighter, and more elastically comfortable than the cast-iron ones formerly used. Fig. 2 shows an outside view, and Fig. 3 an axial section, of a new horse-shoe calk made entirely in dies from a flat disc of cold steel, at several operations, even to the square hole inside

FIG. 2.

FIG. 3.

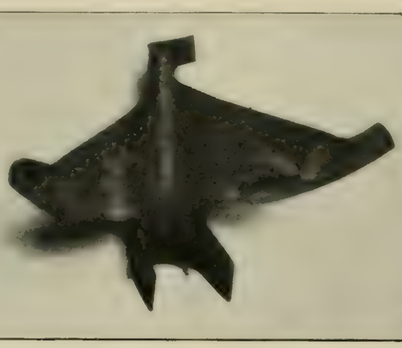


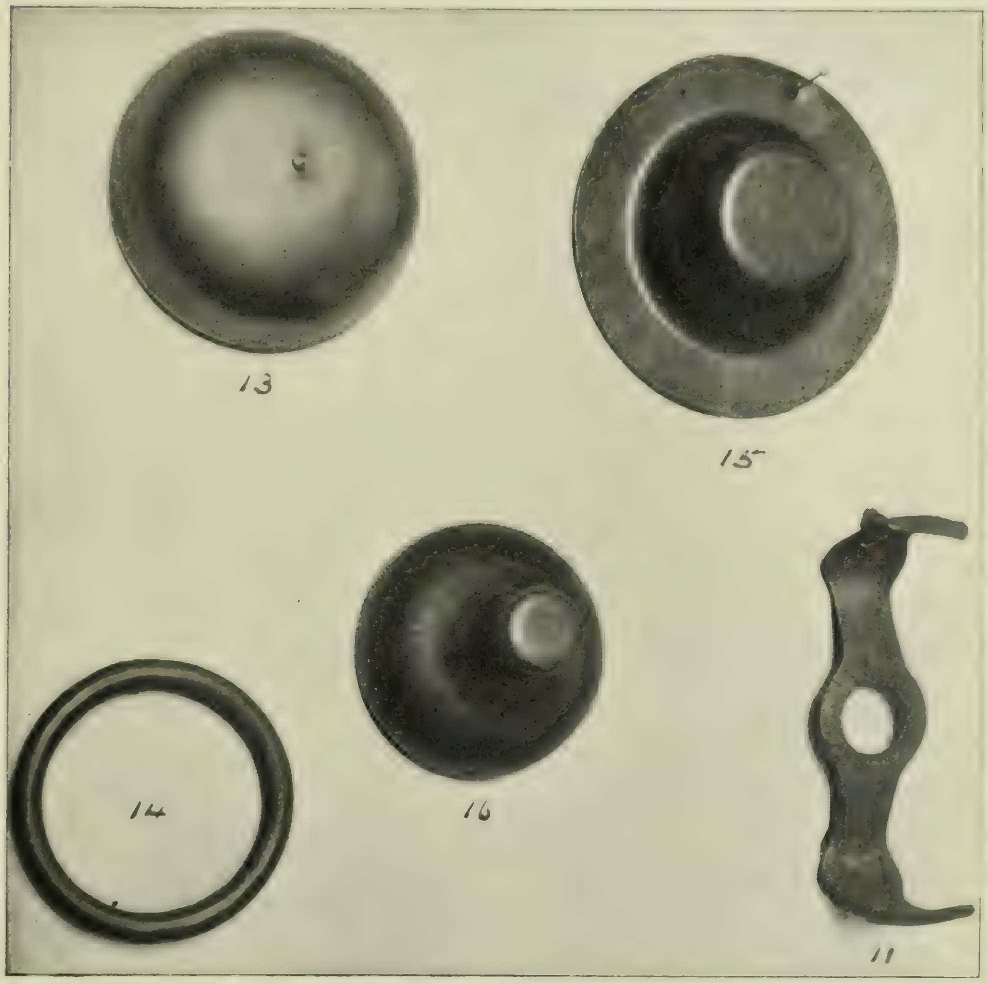
FIG. 4.

which fits the wrench by which it is screwed in. Fig. 4 shows a calf-weaner, whatever that term may imply, the writer not having sufficient knowledge of stock-raising to explain the details of this apparent barbarity.

Figs. 5, 6, 7, and 8 show well-known forms of can-tops and

FIGS. 5 TO 10.

-bottoms, which certainly are not unique, but any one of which a modern press run by a girl will produce from the sheet at the rate of from 10,000 to 20,000 a day. Were the tin-plate of which they are composed made, as it ought to be, and as inventive ingenuity will soon enable it to be, in long, reeled-up strips instead of small, square sheets, these presses could be automatically fed, and the articles produced at a much more rapid rate. Figs. 9 and 10 show zinc fruit-jar and oil-can tops respectively, and Fig. 11 a steel jar-clamp.



FIGS. 11, 13, 14, 15, AND 16.

Pertaining to the household: Fig. 12 shows a pressed-out lid for a butter-dish, this being cut and drawn in one operation from plate silver or other metal, and deepened and embossed at a second operation. Fig. 13 shows an ordinary gong-bell, which, until a very few years since, had to be cast in brass and turned all over, one skilled workman producing but a few dozen per day, whereas an unskilled boy can now turn out complete bells at the rate of 8,000 to 10,000

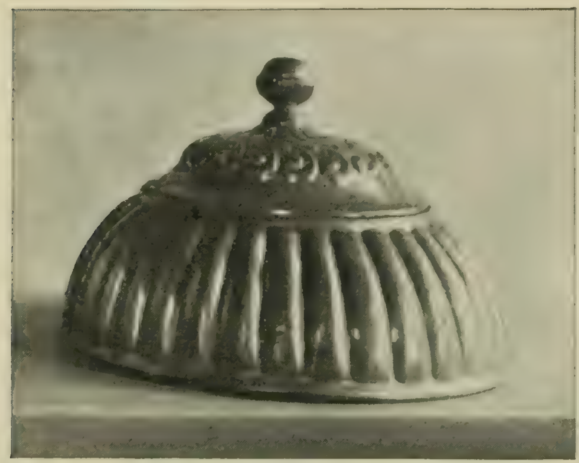


FIG 12.

per day. This is done at one stroke each, in ordinary cutting-drawing dies, from flat sheets of steel or brass, no turning afterwards being required, and the edge being incidentally hardened to a greater extent than the middle, with the result of an excellent tone from the cheapest sort of metal. When we consider the quantity of these bells in use, it can be seen that the saving is enormous. Fig. 14, illustrated on the page preceding this, shows an ordinary curtain-ring, which one cheap workman can make at two operations from thin sheet brass at a rate of many thousands per day. Figs. 15 and 16 show the first and last of a series of press operations, in making the rear part of an ordinary door-knob. Fig. 17 shows a knob of a different pattern, with the rear and front parts put together, the seam not showing ; these pieces are made from the sheet in one or two operations, and the clinching also is performed in a press. Such articles until recently were cast and turned. Fig. 18 shows the first operation in the making of a coffin-plate.

Figs. 19 and 20 show two very different forms of nut-locks used on railroad tracks and in other places. The first is made from the

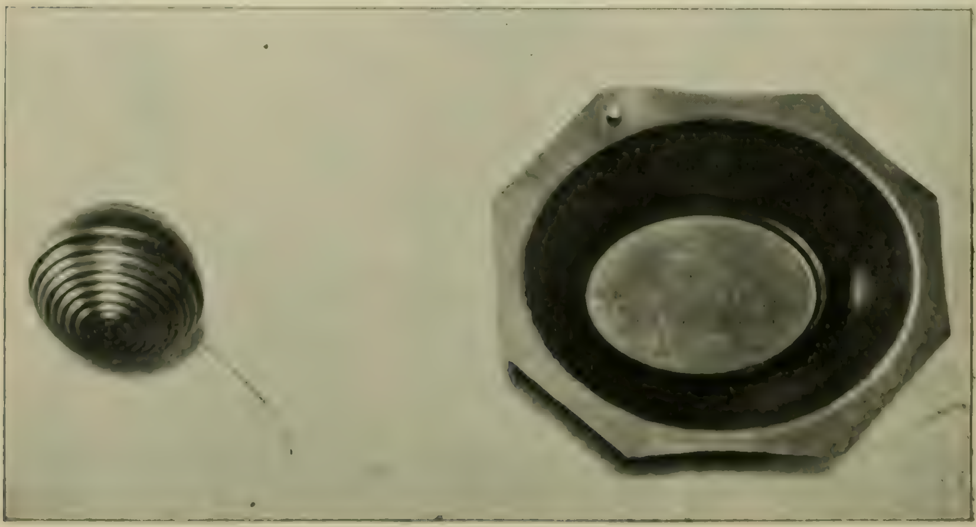


FIG. 17. FIG. 18.

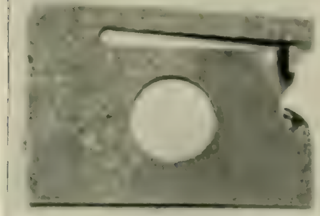


FIG. 19.

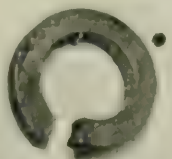


FIG. 20.

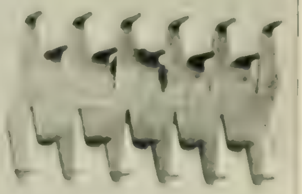


FIG. 21.

sheet at two or three operations, and the second from square bars in one or two operations.

Fig. 21 is an illustration of a new form of belt-hook produced in two operations from the sheet. Fig. 22 shows a seamless elevator bucket, produced from the sheet in three operations, as a substitute for the riveted buckets formerly, and still frequently, used. Indeed, many such articles have been, and are, made of malleable castings.

In our numerous dynamo and electric motor factories, vast quantities of sheet-iron notched discs are used for building up laminated armatures. One of these is shown in continuous form in Fig. 23, while in Fig. 24 is shown a segment of a built-up ring for the same purpose. These are now extremely commonplace objects, but they well illustrate the enormous importance of press and die work in one of the greatest industries of the age.

In military, as well as civil, life we find numerous adaptations of stamped work, not only in a little belt-clasp as shown in Fig. 25, and in buttons, canteens, sword-scabbards, etc., used upon the person, but in the vastly more important line of cartridge making. Indeed, our modern system of loading small arms could not exist were it not for the thousands of presses daily engaged in drawing the copper shells which serve as the skele-

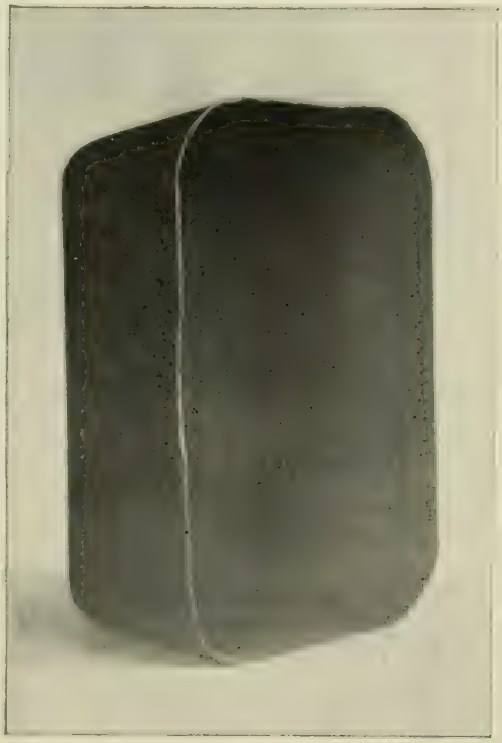


FIG. 22.

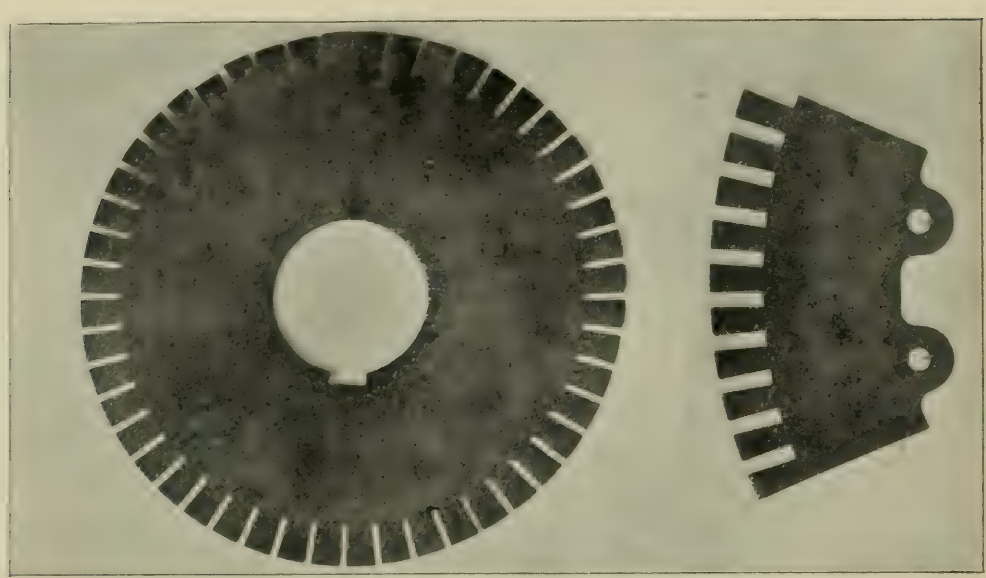


FIG. 23. FIG 24.

tons for our lead- and powder-charged cartridges. If we look further, we find that numerous parts of guns and pistols are cut from the sheet, or, in more numerous instances, made nearly to shape in a drop press.

Considering larger game, it would hardly have been thought heretofore that steel cannon would require the use of presses and dies, except huge squeezing presses as substitutes for steam-hammers in compressing the ingots. It now appears, however, that some genius has recently devised a cannon which seems practicable, made of numerous discs of sheet-steel—which, of course, can be cut very rapidly, cold, in an ordinary press—so piled together that their united thicknesses represent the length of the gun, the whole structure being aligned by a central tubular core and held together by external bolts.

Fig. 28 shows a group of spring-plates, so called, used in connection with the gangs of springs in the trucks of railroad cars. Fig. 29 shows a stake-pocket used upon the sides of

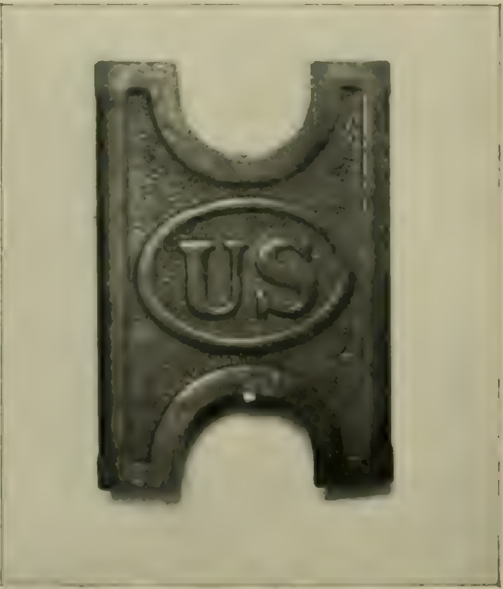


FIG. 25.

platform cars. Not only have such articles as these, quickly pressed from sheet-steel, almost taken the place of the cast ones used a few years ago, but many truck-frames, and even car-wheels themselves, are now being made by the same methods.

The remaining pictures refer entirely to bicycle work, but do not by any means cover the ground. An analysis of this wonderful, popular, and now very-much-cheapened machine will show that it could hardly exist except for press-working methods—at any rate, not in its present light and low-priced form, where we see a vehicle of remarkable capabilities weighing 25 pounds and in some cases retailing as low as $25, notwithstanding the fact that it is made of hundreds of pieces of steel, with wonderful refinement in strength, accuracy, and smooth and noiseless running. In Figs. 31, 32, 33, 34, and 35 are shown in their natural sequence (some intermediate pictures omitted) five of the dozen and more operations necessary to produce a complicated "crank-hanger" from a flat piece of steel, the operations all being conducted cold.

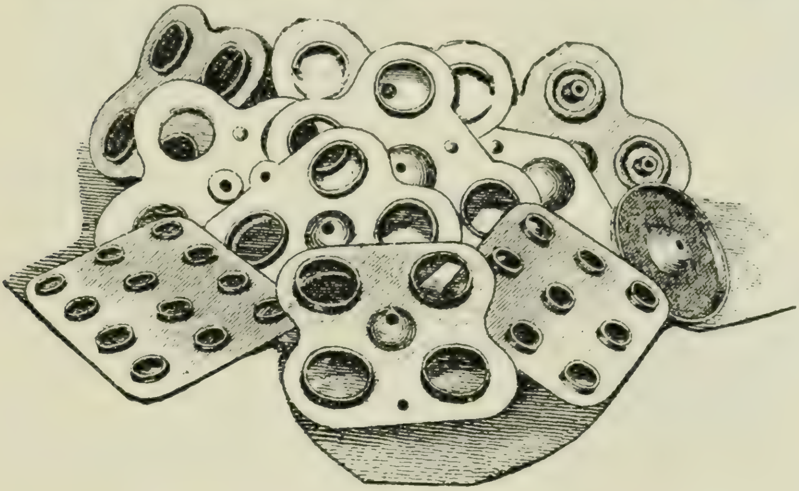


FIG 28.

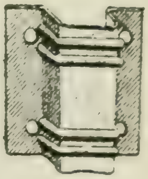
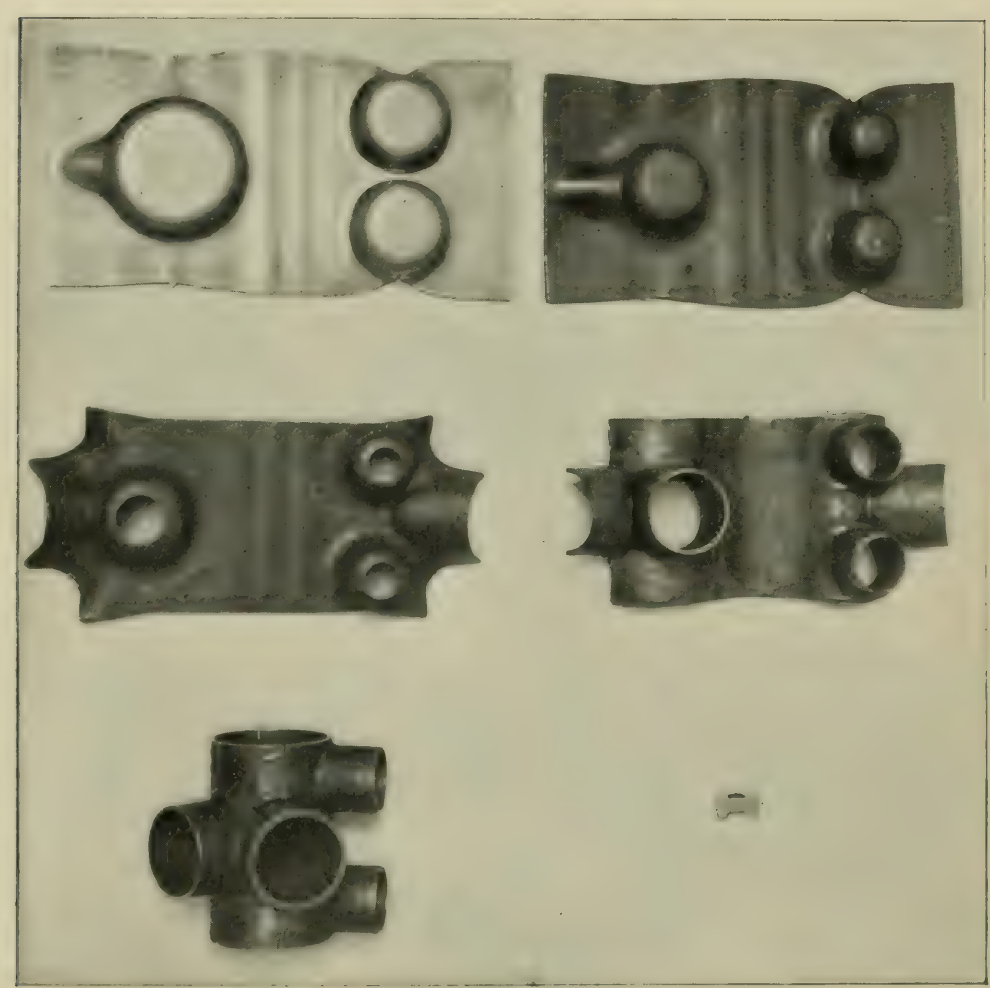


FIG. 29.

Fig 36 shows a small double dovetailed tongue, which, in the crank-hanger mentioned, is used for locking the joints together, although in most cases this additional fastening is omitted. An article of this kind is, of course, brazed in all its joints, after being formed to shape. Figs. 37 and 38 show the two forming operations, used after the blank has been cut to shape, in making another well known fitting used in the frames of bicycles.

Fig. 39 shows another familiar bicycle fitting, made in one piece at several operations. The ingenious slitting and looping in the centre of this piece to obtain a tapped hole for the rear-axle adjustment-screw show an ingenious adaptation of one of the capabilities



FIGS. 31 TO 36.

of sheet-metal work, where ordinarily a solid and thickened-up boss would have to be drilled and tapped.

This, and the two fittings just described, are substitutes for the vastly more expensive fittings formerly employed, and still to a considerable extent used on all sorts of bicycles. All of these were formerly forged roughly to shape, the cavities being drilled from the solid, and

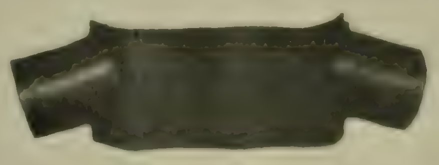


FIG. 37.

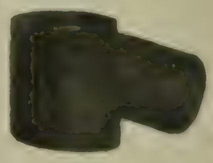


FIG. 38.

the outside finished by turning, milling, etc. Figs. 41, 42, 43 and 44 show the four operations necessary for producing a bicycle foot-rest, which obviously can be made at an extremely low cost. Some of these, indeed, are retailed at five cents a pair—duly nickel-plated and equipped with bolts and nuts.

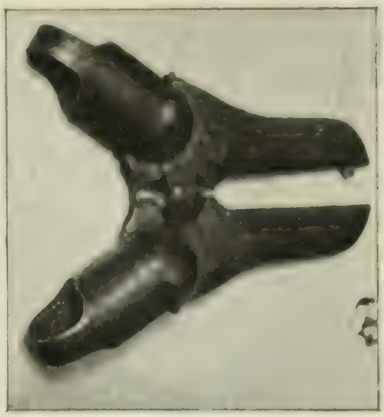


FIG. 39.

Fig. 45 shows a side-piece of one popular form of bicycle pedal, which is simply cut from the sheet at one operation at the rate of perhaps 100 per minute for each press, several presses being attended by one operator. Fig. 46 shows a unique form of bicycle pedal frame, many of which, of the same appearance, are cut out from a flat sheet, bent around, and electrically-welded together. This particular

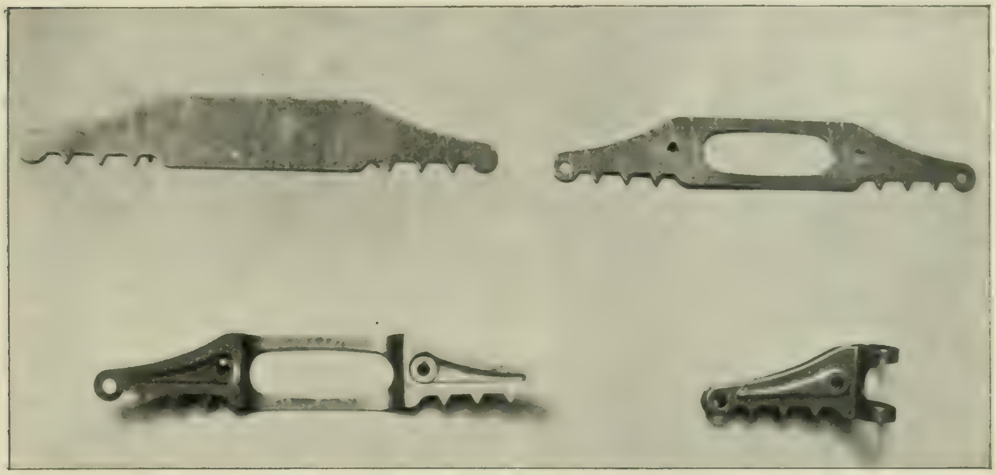


FIG. 41. FIG. 42.
FIG. 43. FIG. 44.

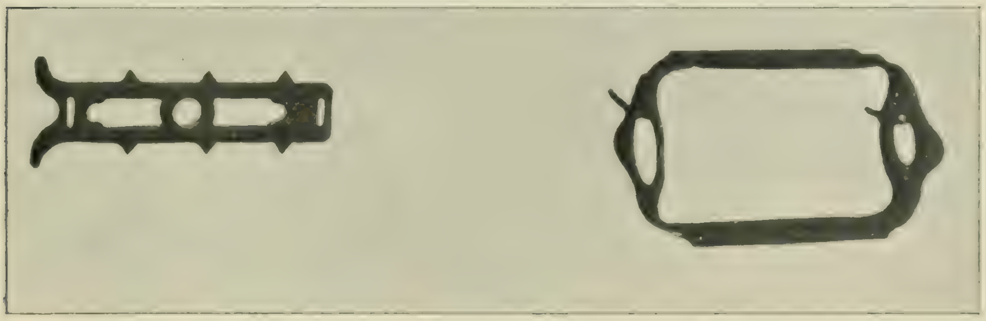


FIG 45. FIG. 46.

one, however, is seamless, and is made by a new process, cold from the sheet.

Fig. 47 shows a piece of scrap, and Fig. 48 one of the bicycle-chain links punched therefrom. Strips of this sort can be fed to a press running at the rate of more than 100 strokes per minute; and dies can be set in gangs, as shown, to cut as many links at a time as desired, the number in this particular case being three. The apertures in the link can be made at the same time, properly-set gangs of punches perforating the metal a stroke or two ahead, and the contour of the link afterward being cut around them,—a method which is known as the "progressive" system of cutting dies.

In Figs. 49 and 50 are shown a ball-cup and handle-ferrule for bicycle work, either of which can be rapidly made cold in from one to three operations.

Figs. 51 and 52 show the first and last operations on a peculiar kind of bicycle tube. The metal is bent around and interlocked with a series of dovetailed joints, all the operations being performed in ordinary presses and the joint afterwards brazed. Fig. 53 shows, in a nested group several of the successive operations used in tube drawing, while Fig. 54 shows a cup similar to the largest one in the group just mentioned, partly turned inside out, the turning operation being effected after the manner in which some people pull off

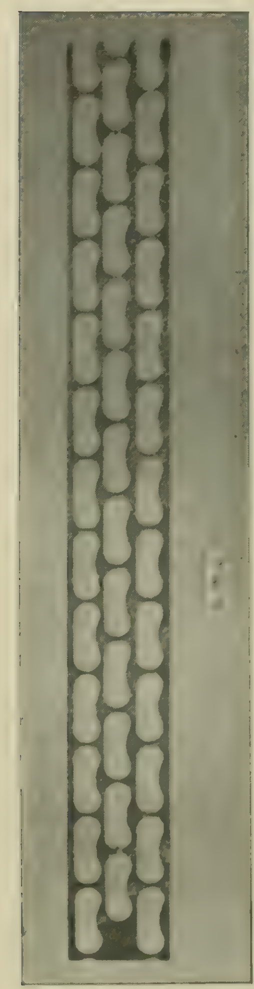
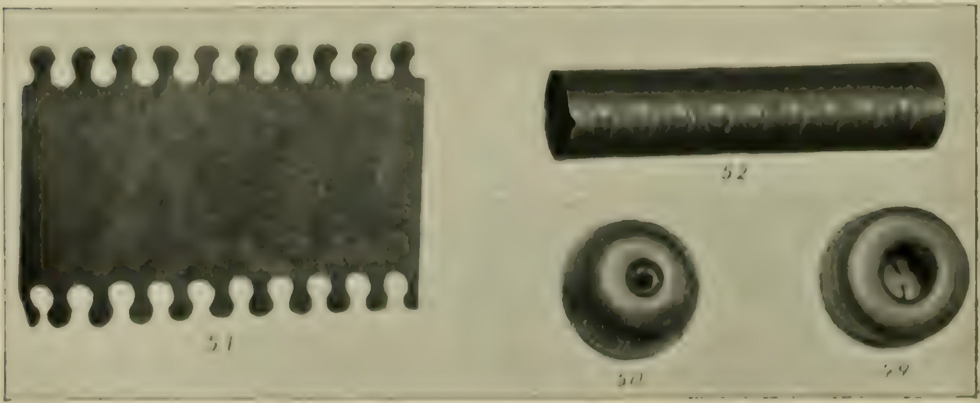


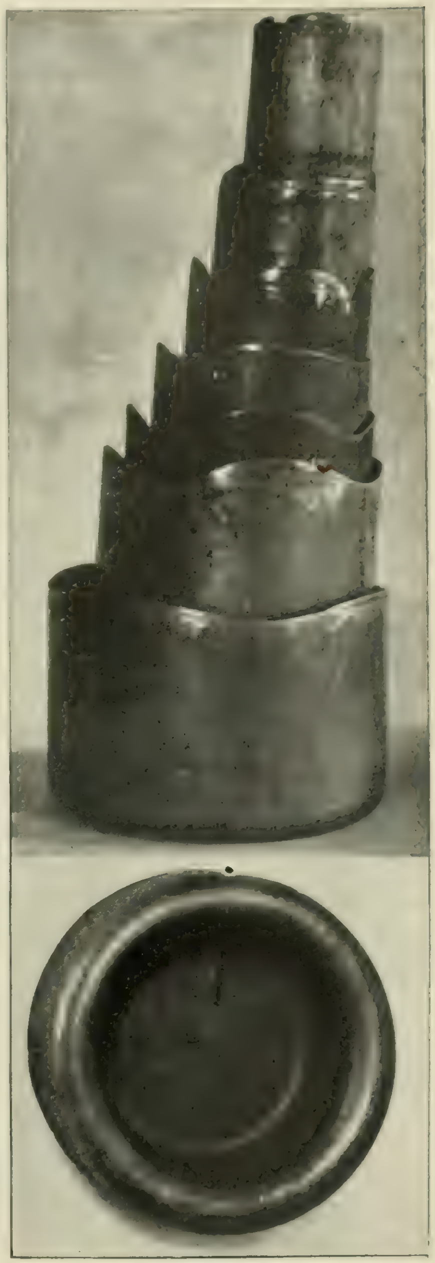
FIG. 47. FIG. 48.



FIGS. 49 TO 52.

their stockings. In this case the motion of the press was arrested midway, and the cup taken from the dies, to show its incomplete condition. A large portion of all the steel bicycle-tubing now made, including much of the high-grade, is drawn cold from flat sheets by the system indicated—the turning inside out not being essential to the system, however, and occurring only upon special occasions. The fact that this method is so extensively used indicates that it is cheaper and better, on the whole, than the system of drawing tubes from hollow cast or forged ingots. It is strictly press and die work, especially in the first stages of drawing the cups and reducing them until they approach the proportions of a tube proper.

Fig. 55 shows a bicycle hub made from steel tube, by swelling out and upsetting the metal, in an ordinary press, to form the flanges. A still more elaborate form of hub has recently been devised, in which it is not necessary to have a separate lining piece, the various thicknesses required being drawn in a short special tube, before the flanges are made. Such a hub is an excellent substitute for those made from solid metal, some of which are forged roughly to shape and then drilled and turned, while others are drilled and turned at the same operation from a bar large enough



FIGS. 53 AND 54.

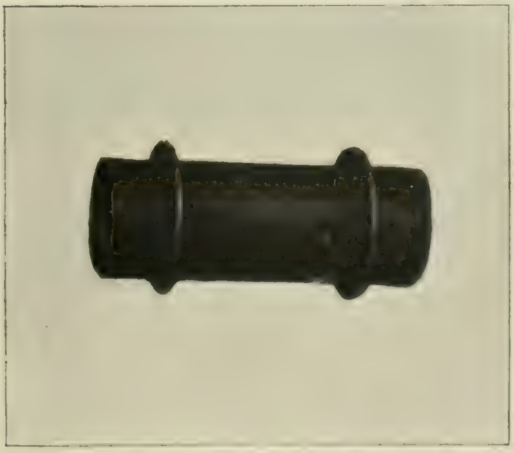


FIG. 55.

to cover the flanges. In either of these cases, the waste of metal is enormous, and the labor and time very considerable.

In general, mechanical analysis of the modern bicycle shows that a large proportion of its hundreds of pieces may be made, wholly or partially, by some of the processes we have been considering, the principal exceptions being its studs, bolts, etc., which are produced in rapidly-working automatic turret-lathes. Even the spokes of the wheels, ostensibly of wire, are reduced in dies by a swedging operation closely resembling the action of a press. The leather of the saddles is first cut, and afterwards formed with presses and dies, and wooden rims are confined in special dies while being glued, as are also the rubber tires themselves during the vulcanizing process.

It is safe to say that, without the aid of press-working processes, the modern bicycle would be but a luxury for the rich, and not, as now, the vehicle, companion, and friend of the poor.

It must be remembered that, with the stamping methods we have considered, there is not only a uniformity of production which enables the different pieces of an article to be assembled without machine-work and hand-fitting in a way that is impossible with rough forgings or castings, but that the labor item and the general "expense rate" of the factory are reduced in an almost marvelous degree. The various operations in press-work can easily be performed at the rate of 1,000 to 100,000 per day of ten hours, 10,000 being a fair average for light articles by hand-feeding, and this with an unskilled operator. Such rates of production are entirely unapproachable by most of the other methods used in manufacturing metals.

The production of very many of the necessities and luxuries of our modern civilization by machinery such as we have considered has been so wonderfully cheapened as to create an enormous demand for things formerly unattainable by the masses. This has not only added to the sum of available happiness, but has furnished employment to vast numbers of operatives in the various industries concerned, making the subject under discussion an important factor in problems of economic science. The special development in this line which has occurred in America within the last few decades may perhaps have contributed considerably to the economic forces which have acted to produce the better general conditions and the higher rate of wages enjoyed by American workmen, in contrast with those of the east, and enabled the United States to export so many of their manufactured goods, in spite of the cheaper labor existing abroad.

THE RECOVERY OF BY-PRODUCTS OF THE BLAST FURNACE.

By A. Humboldt Sexton.

IN England and in America, where the blast furnaces are fed with coke, the only by-product is the gas, and for many years this has been utilised almost universally for heating the blast and for raising steam ; but in Scotland and some other localities, where the fuel used is raw coal, the gas carries with it tarry matters and ammonia to a considerable value, and these, until recently, were allowed to be lost.

The recovery of every possible item of value is a matter of continually increasing importance in the iron trade. It has recently been pointed out in these pages* that, " if the British coke industry were to utilise by-products and waste gas generally, they would be able to furnish considerably cheaper supplies of coke to iron smelters, and this is a reserve of strength that can always be resorted to in case of need—the more readily as most of the large smelting firms have their own collieries and coking plants. There would be no good reason why pig-iron makers in Cleveland, for example, should pay 12s. to 14s. per ton for coke on which the railway transport is only 2s. 6d. per ton, if the coke-maker took advantage of his opportunities to economise in the process of coke making, and if British smelters were satisfied to accept and use coke from by-product ovens, as is done in Belgium and Germany."

Ordinary Scotch splint coal, such as is used in the blast furnaces, yields only about 60 per cent. of coke,—sometimes less,—and, as the fixed carbon is the only portion of the fuel which is of any use in the blast furnace, a large quantity of coal—from 32 to 36 per cent.—is required for each ton of iron produced. The coal contains about 1.4 per cent. of nitrogen, and, if the whole of this were evolved as ammonia, it would yield about 143 pounds of ammonia sulphate for each ton of coal consumed. In practice only about 10 per cent. of the nitrogen is evolved as ammonia ; so that the yield of sulphate is only about 22 to 26 pounds for each ton of coal used. This seems a very insignificant amount, but, when the large quantity of coal consumed in an ordinary blast furnace is taken into account, it will be seen that the total yield may be very considerable.

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* J. Stephen Jeans, in The Engineering Magazine for January, 1898.

No doubt many iron-masters, seeing the tar accumulating in their gas mains, and hearing much of the great value of gas tar, had visions of the profit they might make by recovering and selling this with any possible ammonia ; but from dream to realization is a long step, and no one cared to be the first to attempt it, for the outlay would certainly be very large, and the profit to be realized was problematical. Under such circumstances some one more daring or more far sighted than his neighbours is sure to arise and carry out the work about which they are hesitating ; and so it proved in this case, the pioneers being Messrs. Alexander and McCosh, of the great firm of Baird & Co., Limited.

The Messrs. Baird for nearly seventy years have been in the van of the Scottish iron industry. They were the first manufacturers to take out a license to use the hot blast under Neilson's patent at the Gartsherrie works, then just started, and in 1879, almost exactly fifty years later, they decided to make the most important advance that has been attempted in the industry since that time.

When the problem was studied, the difficulties were apparent enough, the most important being the vast amount of gas which would have to be dealt with and the absence of data as to the methods of removing so small a quantity of condensible matter from so large an excess of gas. In the gas works each ton of coal yields about 10,000 cubic feet of gas, which carries with it the products to be recovered ; but in the blast furnace each ton of coal yields about 12,000 cubic feet of gas with only about the same amount of recoverable material scattered through it. Then the total amount of gas to be dealt with is very large. A furnace consuming 80 tons of coal a day would give about 9,600,000 cubic feet of gas in that time. This volume may be best realized by comparing it with the amount of gas made for the supply of a large city. The gas department of the corporation of Glasgow supplies a population of nearly 1,000,000 people, and the total amount of gas made in all its works per day is about 12,400,000 cubic feet,—much less than the amount produced by two blast furnaces

The works at Gartsherrie, to which the recovery plant was to be applied, consisted of sixteen furnaces, arranged in two rows of eight, one row each side of the yards, and it was decided to begin with one side only, eight furnaces.

In 1879 the furnaces standing were very small and of an old type, each consuming about 60 tons of coal per day. These furnaces have now been replaced by others of more modern design and larger size, but the recovery plant at first erected is still in use.

It will be seen that the plant had to be designed to deal with about

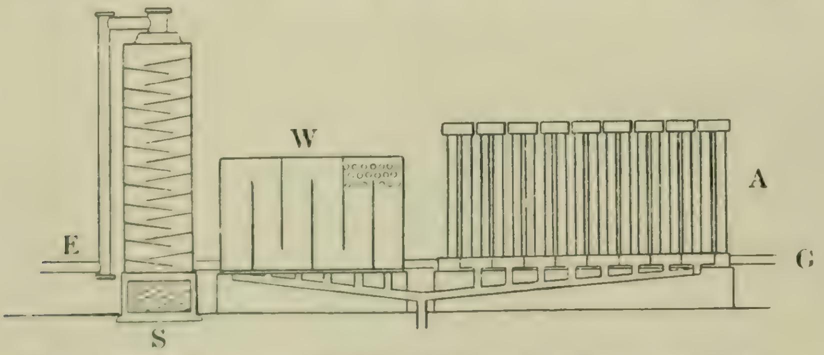
$130,000 \times 60 \times 8 = 62,400,000$ cubic feet of gas per day; and, as the replacement of the furnaces was then in contemplation, it was necessary to give it somewhat greater capacity than would otherwise have been necessary.

After a large number of laboratory experiments, some of them on a very large scale, Messrs. Alexander and McCosh decided that the plant should be built on the principle in general use in gas works,—*viz.*, that the gas should be well cooled, and then washed with water. The wisdom of this selection has been amply justified by experience, as all the recovery plants now in use are based on this principle, while other types have been tried and abandoned. The chief problem to be solved is this: Given 130,000,000 to 150,000,000 cubic feet of gas per day, leaving the furnace at a temperature of about 600° F., and having to be cooled to, say, 60° F., whereby its volume will be reduced to 60,000,000 or 70,000,000 cubic feet, to cool it, and then to remove the small quantity of condensible products disseminated through it.

GENERAL VIEW OF ONE SIDE OF THE GARTSHERRIE WORKS, AS IT WAS IN 1880.

It need hardly be said that no experimental data existed, either as to the amount of cooling surface that would be necessary, or the amount of washing-water that would be required; so the designers had to ascertain these for themselves. The cooling was comparatively easy, but the removal of so small a quantity of condensible matter in so large a mass of gas presented great difficulties, for, even after the temperature has been so reduced that condensation must be complete, the condensed products show but little tendency to settle, but are carried forward by the gases in the form of very finely-divided mist, which can be removed only by thorough washing or scrubbing.

Messrs. Alexander and McCosh adopted very thorough cooling, and a final scrubbing, as their leading principle. Messrs. Dempster, who were the next to erect a plant, adopted cooling, washing, and scrubbing, while Mr. Gillespie, who is the latest comer, dispenses altogether with the scrubbers, and depends on cooling and washing. Almost all the Scotch iron works are now fitted, or being fitted, with recovery plant. The various works of Messrs. Baird & Co. have the Alexander and McCosh plant ; most of the others have the Dempster plant, while the recently erected plants are those of Mr. Gillespie.

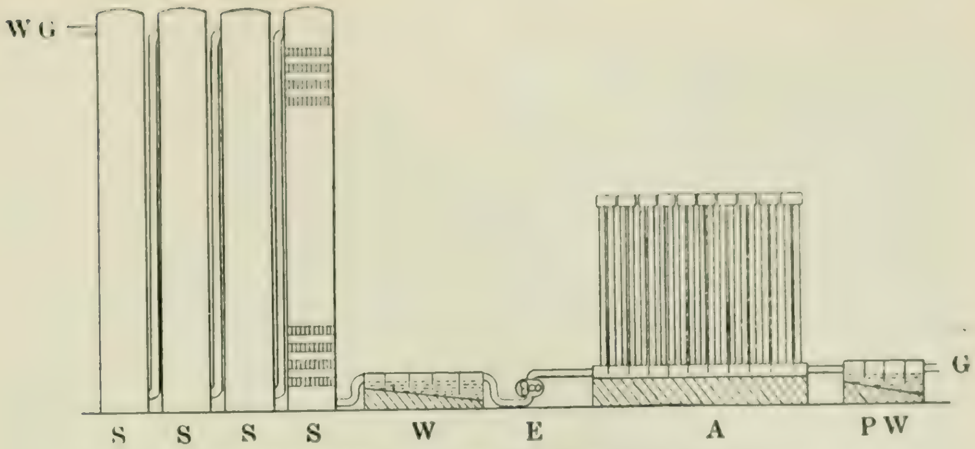


DIAGRAMMATIC SECTION OF THE ALEXANDER AND McCOSH PLANT.

A, atmospheric condenser ; W, water condenser ; S, scrubber ; G, gas main from furnace ; E, main to exhaust.

The gas leaving the furnace passes through a dust catcher, and then, by a long main, to the first condenser ; in so doing it cools somewhat, and a certain amount of sticky tar deposits. In some works the hot gas is made to assist in the dehydration of the tar before it enters the atmospheric condensers. In the Gartsherrie plant the gas passes at once to the cooling tubes, but in the others it is made to pass through a primary washer filled with tar, by which most of the dust which has not been caught in the catcher is kept back, and some of the tar is collected. This washer may be made to act as a very effective valve or tar seal, cutting off the communication between the furnaces and the condensers when necessary.

The first cooler consists of a series of vertical iron pipes. In the Gartsherrie plant these are 40 feet high and 2½ feet in diameter, and are 200 in number, arranged in twenty rows of ten each, so that every particle of gas has to travel through twenty tubes alternately up and down. The tubes are so arranged that the condenser can be sprayed



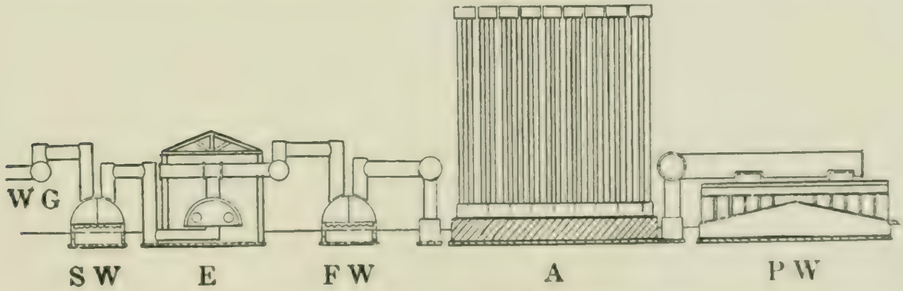
DIAGRAMMATIC SECTION OF DEMPSTER PLANT.

PW, primary, or tar, washer; A, atmospheric condenser; E, exhaust; W, washer; SSSS, scrubbers; G, gas main from furnaces; WG, washed gas to stoves, etc.

with cold water in hot weather. The gases enter at about 400° F., and leave at about 120° F.

In the other forms of plant the atmospheric condenser is on the same principle, but the number and size of the tubes varies with the amount of gas to be treated. In the Gillespie plant, the tubes, instead of standing on one large tar box, stand each row on a separate box, so that any one row can be shut out of use for cleaning or repairs without interfering with the rest. In the Gartsherrie plant still further cooling is used, the gas from the atmospheric condensers passing into a water-cooler,—a large iron chamber 45 feet long, 45 feet high, and 18 feet broad, crossed by 2,700 iron pipes, through which water is kept constantly circulating, the water entering each tier of pipe at the further end and travelling backwards and forwards across the chamber, while, by means of suitable partitions, the gases are made to circulate up and down on their way, and so come in contact with the whole of the pipes. The gases leave this condenser at about 60° F.

In the Dempster plant this second cooler is replaced by four sets



DIAGRAMMATIC SECTION OF GILLESPIE PLANT.

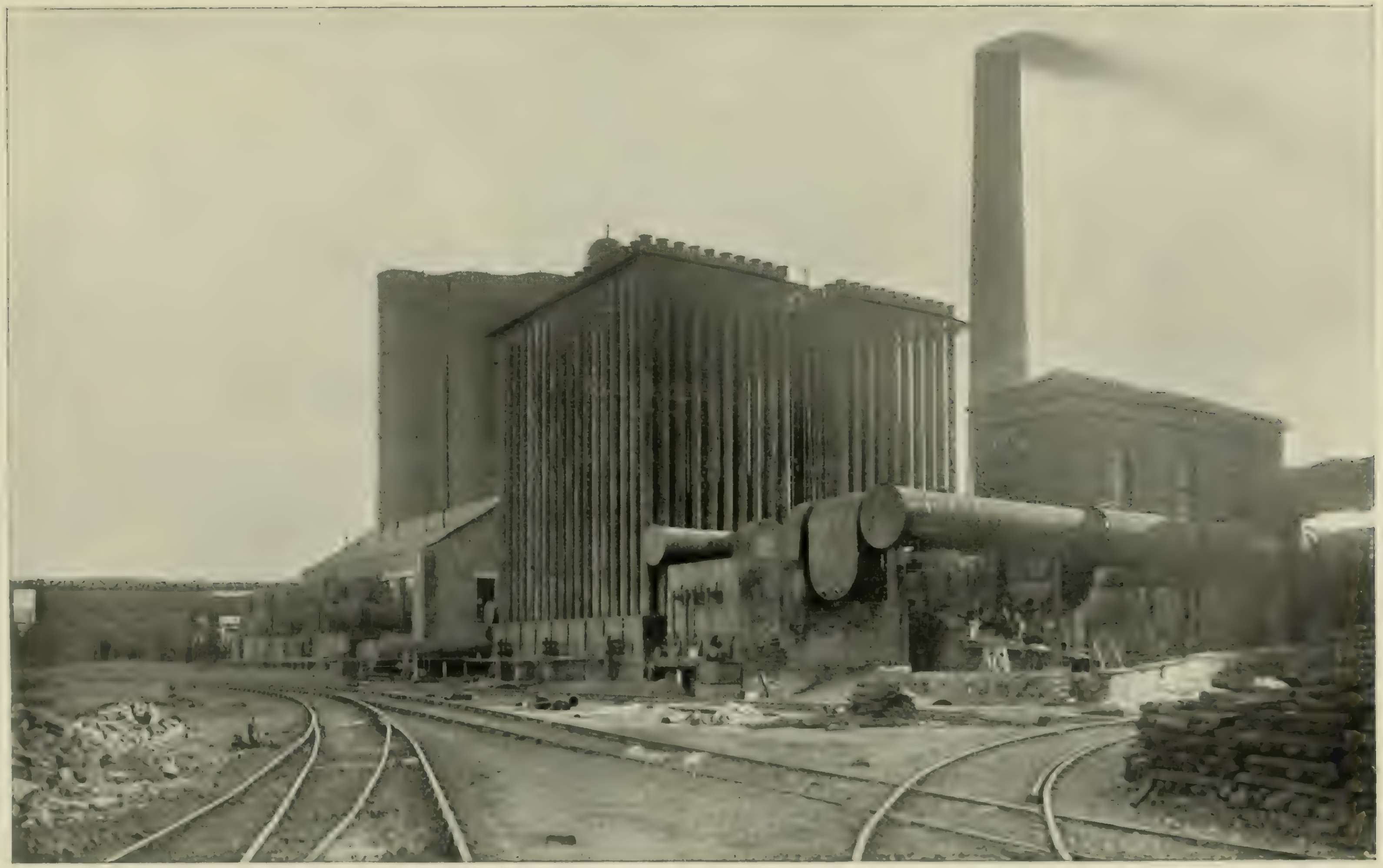
PW, primary washers; A, atmospheric condenser; FW, first washer; E, exhaust; SW, second washer; WG, washed gas to stoves, etc.

of washers, which are crossed by perforated plates so as to break up the gas and, as far as possible, wash out the tar before it passes to the scrubbers. Neither the complete cooling of the Gartsherrie plant or the combined cooling and washing of the Dempster plant is sufficient to remove the tar and ammonia ; so the gas is next passed to the scrubbers, of which, at Gartsherrie, there are two. The first is 80 feet high and 25 feet square, while the second is 60 feet high and 20 feet square, both being crossed by a large number of sloping perforated shelves. Down both of them a rain of water is kept constantly falling.

In the Dempster plant four scrubbers are used. These are about 100 feet high and 12 feet in diameter, and are packed full of wooden boards set on edge—about three hundred tons of wood being used—so as to effectually break up the gas and bring it in contact with the water. The gas ascends the four scrubbers successively. The liquor from the last scrubber is pumped up to supply the next, and so on, the gas travelling in one direction and the washing-water in the other.

GENERAL VIEW OF THE ALEXANDER AND McCOSH PLANT AT GARTSHERRIE.

At first sight it seems that washing—*i. e.*, bubbling the gas through water—should be more efficacious in removing matters in suspension than scrubbing with a shower of descending water, but, as a rule, this has not been found to be the case. When gas bubbles through water, only the surface of the bubble comes in contact with the water, and thus solid or liquid matter may be carried through untouched. If the gas could be broken up into small enough bubbles, washing could be made quite as effective as scrubbing. Mr. Gillespie, in his plant, does away altogether with the scrubbers, substituting



GENERAL VIEW OF THE DEMPSTER PLANT AT GLENGARNOCK.

THE GILLESPIE WASHERS.

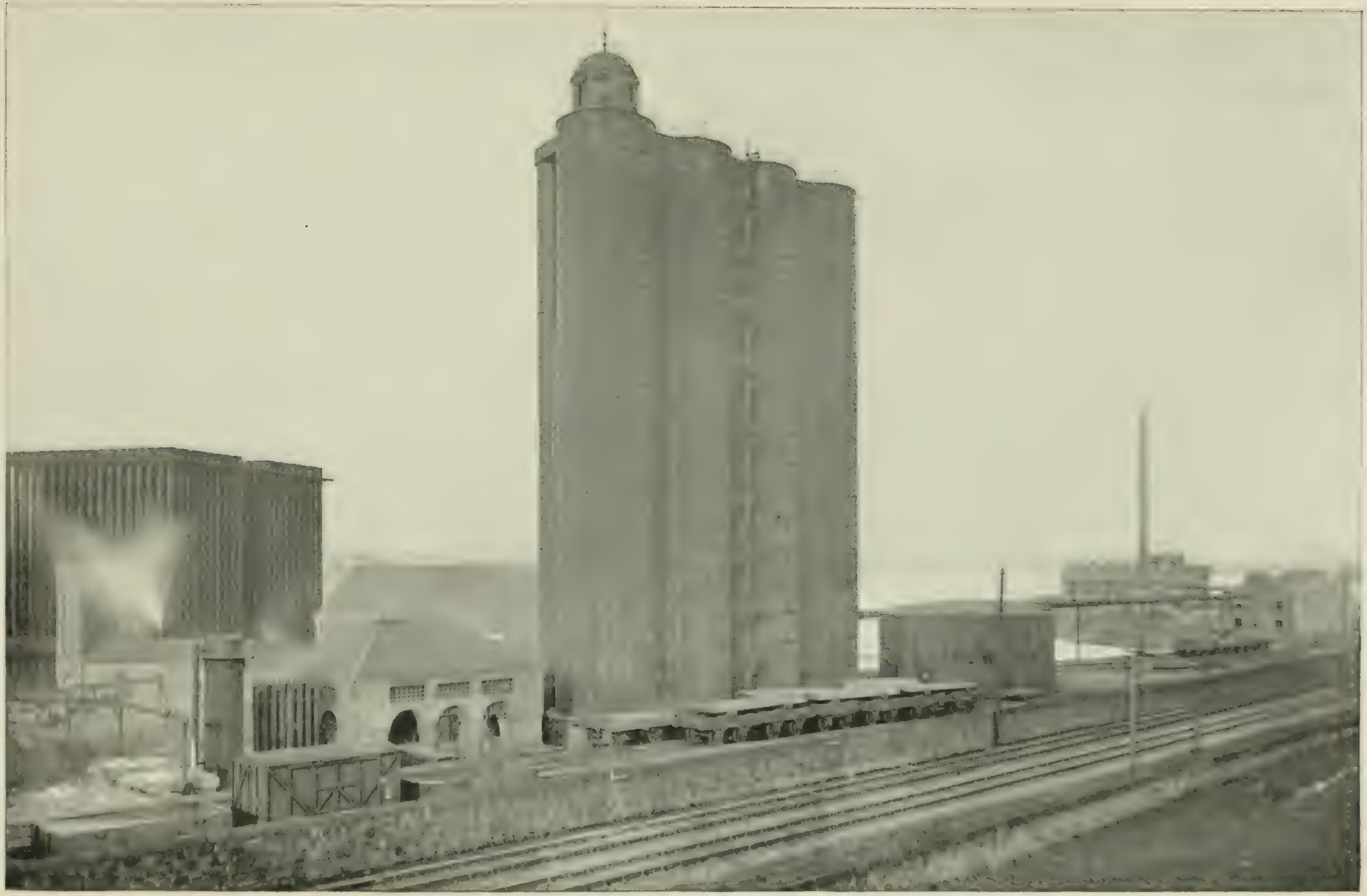
washers of a peculiar form. The chambers of the washer are divided by plates having finely-serrated edges, so that the gas is broken up, and at the same time the current of gas is much reduced in speed by making the area of the washer very large in proportion to that of the mains by which the gas reaches them. These washers are said to be very effective in removing all tar and ammonia, two sets of washers being used in conjunction with one set of atmospheric cooling-tubes.

Whatever form of plant may be adopted, the resistances introduced are so great that the gas must be drawn through and carried forward to the boilers where it is to be burned. Various forms of exhaust are used,—Root's blowers, fans, and cylinders, the last named seeming the most popular.

The condensed tar and ammonia water are run into large settling-tanks, where the tar sinks to the bottom, and the two are separated in storage tanks. The three products so far obtained are gas, tar, and ammonia liquor.

The gas, as it leaves the exhaust, passes at once to the boilers, or stoves, and is there burned. No doubt the removal of the tarry matters somewhat reduces the heating power of the gas,—how much it is impossible to say,—but this is compensated to some extent by the much greater dryness of the gas. The gas is much dryer than it would be if passed direct from the furnace, because it is much cooler, and the amount of water a gas can carry depends on its temperature. The washed gas is quite good enough for all purposes for which it is required, and, being free from tar and dust, can be used direct in the gas engine, which is a much more economical method of using the gas than burning it under a boiler. This plan has recently been carried out at the Wishaw works of the Glasgow Iron and Steel Company for lighting the works by electricity, and has been in every way successful.

The power developed in the gas engines has been equal to 1



THE SCRUBBERS, GLENGARNOCK.

GILLESPIE ATMOSPHERIC CONDENSERS.

electrical h. p. h. for each 1.8 pounds of coal consumed in the furnace, assuming that each ton of coal gives 130,000 cubic feet of gas. There promises to be in the near future a large development of this means of obtaining power, as the amount of energy obtainable from the blast furnaces of Scotland would be very large.

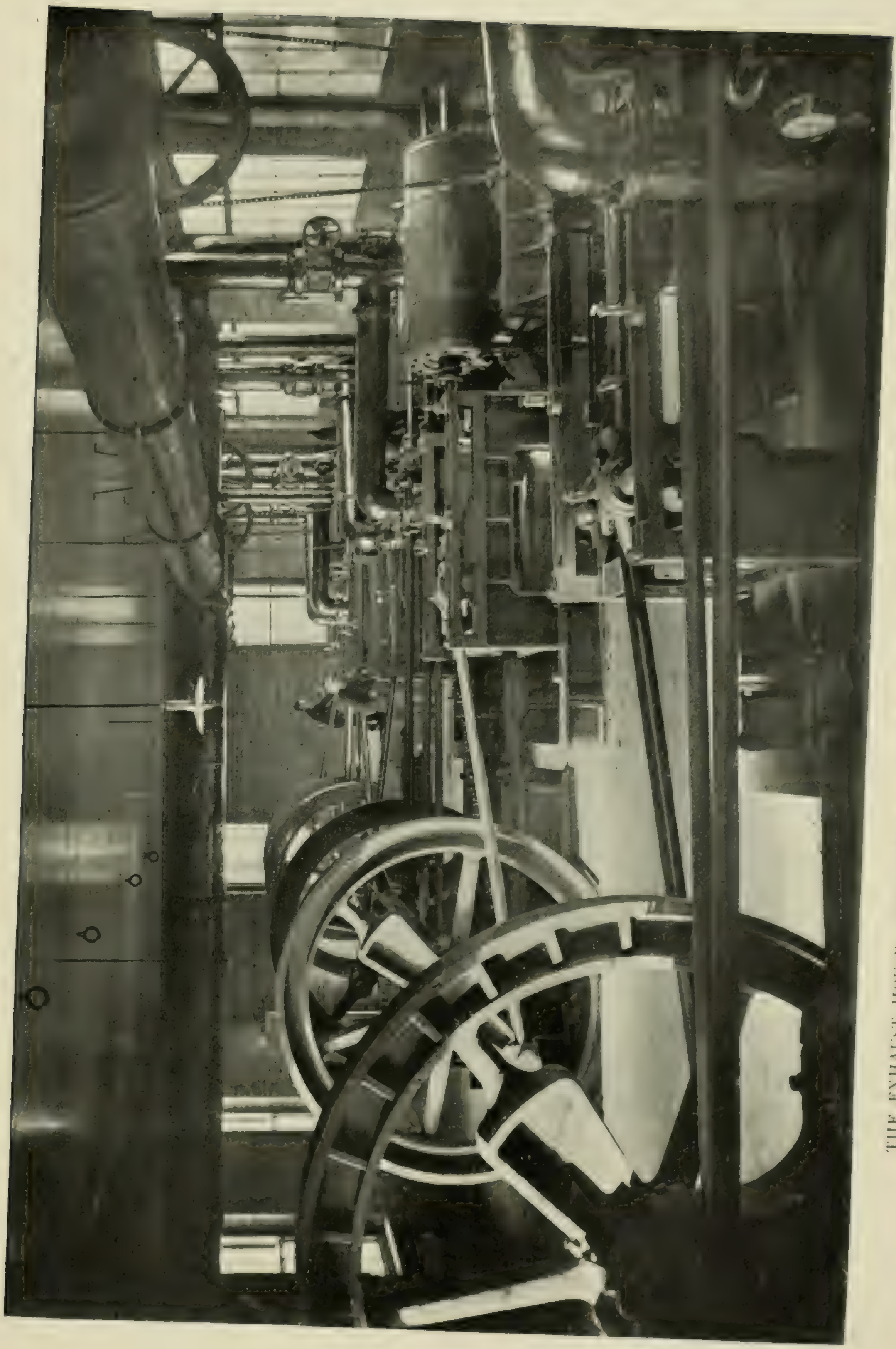
The water containing the ammonia is heated to expel the ammonia, continuous evaporators being used, in which the descending liquor falling over suitably-arranged plates is met by an ascending current of steam.

The ammonia is passed into acid, in lead boxes, and the crystals, as they form, are either pushed or automatically discharged into draining vats, from which they pass to the stove, the draining being in some cases facilitated by the use of a centrifugal drying-machine.

The amount of sulphate obtained is from 22 to 25 pounds per ton of coal consumed, depending on the quantity of nitrogen contained in the coal, of which it represents 15 or 16 per cent., and perhaps somewhat on the nature of the coal and on the temperature to which it is heated, a high temperature tending to reduce the quantity of ammonia. There is practically no loss of ammonia, the escaping gases being almost free from it.

In the gases as they leave the furnace the ammonia is present almost entirely as free gas, the temperature being too high to allow combination with the carbon dioxide, though no doubt traces of sulphate and cyanide may be present. To decompose these a small quantity of lime was always added before evaporation, but the amount of fixed ammonia was so small that this has now been generally abandoned.

The tar obtained amounts to about 40 gallons, or, say, 400 pounds of green tar for every ton of coal consumed, but of this a very large proportion is water. The tar is pumped into boiler-shaped stills, and heated to expel the water. The resulting anhydrous



THE EXHAUST HOUSE, GLENGARNOCK. THE GAS CYLINDERS ARE OUTSIDE OF THE BUILDING.

or boiled tar amounts to about 40 per cent. of the total, or, say, 16 gallons for each ton of coal consumed.

The tar is entirely different from coal-gas tar, and for some time it was difficult to dispose of it, or to use it. It is almost free from the aromatic hydrocarbons, such as benzine, anthracene, etc., and therefore is valueless for the manufacture of the many coal-tar derivatives. It contains phenols, however, and, on distillation, yields oils which can be used for various purposes. Mr. Watson Smith gave the results which were obtained by the distillation of a sample of the tar as follows:

Below 230°, water	30.60	% of distillate
oil	2.91	" "
230° to 300, oil	6.97	" "
300°, oil till oils solidify on cooling.	13.02	" "
Oils solidifying on cooling, a soft paraffin scale	16.75	

The coke left being 21 per cent. of the weight of the tar.

The dehydrated, or boiled, tar is distilled in large stills, the oils being either collected altogether or separated into light and heavy oils. The distillation is stopped while the pitch is still liquid enough to run out, but solidifies on cooling. In one works 10 gallons of oil and 119 pounds of pitch were obtained for each ton of coal consumed.

The oil can be used for various purposes, the principal being as a fuel, for which it is well suited, or as an illuminant in the various blast lamps, such as the Lucigen. At some works the oils are separated into Lucigen oil, which has a specific gravity of about .970,—suitable for the lamps,—and creosote oil, having a specific gravity of about .989, and containing phenols. The latter is used as a disinfectant and as a preservative for timber, and from it an important disinfecting preparation is made.

The pitch is in considerable demand for the manufacture of fuel blocks, or briquettes, which are now made in considerable quantities from small coal obtained from the coal washers.

The recovery of the by-products from iron blast furnaces has now become general in Scotland, almost every works having its own plant, sometimes worked by the iron masters themselves, but more usually belonging to a subsidiary chemical company, which purchases the products and returns the gas to the works. The value of the recovered material is considerable, and the introduction of the recovery processes has done much to help the Scottish iron industry.

The following figures have been officially published with reference to an installation in a works of four furnaces, all of which were making haematite pig:

Coal consumed	2,000	tons per week		
Pig iron produced	1,400	" " "		
Pitch recovered	100	" " "	value	£120
Oil "	20,000	gallons,	"	£125
Sulphate of ammonia	20½	tons,	"	£225
				£470

The wages and other costs of working the plant are put at £30, and the cost of acid at £20 10s., leaving a handsome balance for interest, depreciation, and profit.

The cost of the plant is, of course, large, varying from £5,000 to £10,000 per furnace, so that the interest at five per cent., assuming the higher figure, amounts to about £38 per week.

The recovery of the by-products has thus introduced a new industry into the west of Scotland, and, by the freeing of the gas from tar and dust, has opened new channels for its use.

It is no doubt true that practically the same products can be recovered from the coke ovens where coke is used for the blast furnaces, but that leaves the blast-furnace gas unwashed, and therefore is unsuitable for direct use in the gas engine. It becomes an important question for iron-masters whether, whenever a suitable coal can be obtained, it is not more economical to use it direct, in spite of some disadvantages, rather than to coke it in separate ovens?

THE ADJUDICATION OF WATER RIGHTS IN IRRIGATED REGIONS.

By Elwood Mead.

THE diversity and value of the returns from irrigated agriculture have been much dwelt on, and its superiority to that dependent on rainfall has often been manifested. Of late, however, in the United States, it has been the prolific source of another product, not so desirable, and not usually referred to in this connection. I refer to controversies and law-suits over water rights. As the far east has afforded studies for the engineer in an irrigation practice which is yearly attaining more importance in Europe and in America, the far west, in turn, may throw important light on another phase of the problem.

The growing volume and cost of this litigation, the number and complexity of the questions raised, and the uncertainty which exists as to the time and manner of their final determination render this feature of the agricultural development of the arid States a subject of grave concern to all interested therein. It is already a heavy burden on users of water, a menace to progress, and, unless brought to an end, will seriously affect the security and value of every irrigated farm. In a recent discussion of this question a candid and careful investigator expressed the opinion that the expenses due to defective laws, and especially to litigation over water rights, are already greater in the United States than the total cost of building ditches and reclaiming land. If this is true now, while they are yet in the period of construction and before the banks of the majority of canals have ceased to settle, we may well look with apprehension to the results which are likely to follow, when expanding settlement and growing scarcity shall give greater value to the water supply now being fought for.

There is no necessity for such results. In every arid State water is a free gift to the appropriator, and, so long as the public gets nothing for the water diverted, it should not cost more to fill ditches than to build them. There is something radically wrong with a system which makes litigation cost more than excavation. That this something lies in defective laws is shown by the fact that these controversies exist only in certain States.

It is the purpose of this paper to outline the nature of these controversies, and to show that wherever they have arisen vicious or inadequate laws have been the cause. Before doing this, it may be well to explain to those who live in humid lands that in the arid States it is water, not land, which gives the irrigated farm its value. Of land there is a surplus ; of water, a scarcity. Water must be had to render the land either habitable or productive. Every field of grain in the valley of a river is the result of its bounty. If water is denied, crops wither, and the cultivator has no reward. Hence, titles to water are more important than deeds to land. Whoever controls the river practically owns the land through which it runs, no matter who holds the patent thereto.

There is another vital difference between farming in arid and humid lands. In the latter success depends upon individual effort ; in the former, on wise laws and adequate industrial organization. The farms along many arid rivers are counted by the thousands ; hundreds of ditches supply them. The value of every one of these farms depends upon the just and effective division of the stream, delivering to each user his proper share of the snow that falls on distant mountains. To do this, water must often be carried past scores of empty ditches with thirsty fields below them. The region to be supervised to make a just division of a single stream often embraces many thousand square miles, extends for hundreds of miles along water-courses, from the hills where the waters are collected to the valleys where they are distributed, and frequently crosses county and State boundaries,—in a few instances, international ones. The multitude of rights involved are to a common supply fluctuating in volume from month to month and day to day, while the needs of its users change with every summer's wind or passing cloud.

To insure the success of this division certain things are indispensable. The rights to be observed must be definite and stable, so that each user's share may be beyond dispute. There must be adequate means, and administrative ability of high order to secure their enforcement. The individual farmer or ditch-owner can do nothing. There must be State, or community, control.

Of necessity, therefore, the social and industrial institutions of irrigated lands differ widely from those of humid lands. Laws to control this industry should recognize and conform to these necessities. The importance of this was not realized by the pioneers of the arid western United States.

In addition to lack of knowledge of the laws of other irrigated lands, or the needs of their own, the early American irrigators and lawmakers were not greatly concerned about the welfare of future generations, or engaged in a conquest for their benefit. They endured the hardships and privations of this region not so much to develop its resources as to possess them. That the streams of this vast domain are its life-blood, a great public heritage on the wise use of which depends the ultimate number, comfort, and prosperity of its people, was a conception at first held by a few. To the multitude they were a store of latent wealth to be secured in the most direct way and at the least possible cost, and, when so secured, to be bought and sold, like farms or mines, wheat or corn. Those holding the latter view shaped the earlier laws, and secured recognition of the doctrine of speculative control from the courts; though they were successful, the obstacles to be overcome proved serious.

It is hard to define by law the limits of this ownership. The nature of the title to mines, corn, and cattle is easily understood, but it is otherwise with a river. The water of to-day is not that of yesterday. To give patents to snow which may or may not fall next year is an innovation which lawmakers have been disposed to avoid. What has been done in all States, except Wyoming, Utah, and Nebraska, is to provide for the *appropriation* of water, the beginning of this appropriation to be a filing similar to a mineral location, while its completion, and the nature and amount of the right, are to be determined by the courts. Under the most favorable conditions the framing of these court decrees would be exceptionally difficult. The conditions which have prevailed in the western States have made satisfactory decrees almost impossible. Nearly every appropriator has a different meaning for the term. The laws which assume to define it do so in terms so loose, vague, and often contradictory that it may mean absolute ownership, a right to use equivalent to such ownership, or a right to use alone. It is small wonder, therefore, that courts have not agreed in their interpretation of these statutes. Out of this lack of exactness has come the controversy between those who believe that water should remain public property the right to which belongs to those who use it, and those who believe that water should be personal property, to be bought or sold by those who can secure a title thereto.

To those not familiar with the value of water in irrigated lands the significance of this situation may not be apparent. All, however, know how important are stable and definite titles to land, and how quickly values shrink and improvement ceases when any cloud hangs over ownership. Because of this, the American government has adopted the most careful, systematic, and expensive methods for the survey and disposal of the public domain, in order that both the boundaries and titles to the land parted with may be known and respected for all time. If, instead of this admirable system, with the peace and security which has gone with its operation, the government had pursued a land policy similar to that of many arid States in the management of streams, the government would have made no surveys to determine the areas or fix the boundaries of the tracts of land to be disposed of. It would have established no land offices and issued no patents. Instead, there would have been laws throwing the whole area open to free appropriation without restriction on either the location or the limits of the land which each individual or corporation might acquire. Appropriation would have been inaugurated by driving a stake and posting a notice somewhere on the land appropriated, setting forth the name of the appropriator and the number of acres or square miles appropriated. Next, the claim would have been recorded in some local office having no control over the land. Within a reasonable time thereafter, which might be one year or ten, a fence would have been built around the land appropriated, whereby the appropriator would have become entitled to a patent. This patent, however, would not have come from the sovereign power that made the law, but in the shape of a court decree, issued after a contest with other claimants of the same land.

The operation of such a land law would correspond closely to the history of these water laws. So long as the number of appropriators was limited, and all were engaged in driving stakes and recording claims, it would be immensely popular. Appropriating land would appear to be a short and easy road to riches. But, with the beginning of the fencing period and of settlement, there would be a different state of affairs. It would then be found that there had been scores of appropriations for every acre of land. There would be unending conflicts over boundaries, priority of location, and legality of notice. There would be lawsuits in court and physical contests outside.

The settlement of these titles would cost more than the value of the land, and there could be no assurance of a just or final settlement at any time or at any cost. To the majority of appropriators such a land system would be a calamity, while by those wishing to settle on and improve this domain it would be regarded as a senseless surrender of public property and a wanton sacrifice of public interests.

In every State which makes water personal property, and thus places a premium on the effort to acquire speculative or extravagant rights, litigation begins as soon as an attempt is made to enforce these rights. No matter what the law may be, every man who has created a home by changing an arid plain into a fruitful field believes he is entitled to the free use of the water by which this seeming miracle is wrought, and, if compelled to purchase this from some one who, after receiving it as a free gift, constitutes himself a bar to progress and a legal parasite on actual tillers of the soil, resents such compulsion as a moral wrong.

In detail, each irrigation code is sufficient unto itself. The causes of litigation are not, therefore, the same in all arid States. A few illustrations will be given to show the nature of these differences. They are taken from States where irrigation has reached its greatest development rather than from those conspicuous for their abuses.

California stands first among the arid commonwealths in the cost and perfection of ditches, and in the skill and economy with which water is used. It also leads in the number and cost of water-right litigations. Water in that State is personal property. Those who do not want to appropriate it for use can appropriate it to rent or sell. There is no limitation on the volume which may thus be claimed. Water rights are located exactly as mining claims are, and the records of appropriations from a single stream, instead of being filed in one place, are divided between the several counties through which the river or its tributaries may flow. There is no special tribunal for the adjustment of these conflicting appropriations, or system of administration when rights are once determined. There are extravagant rights acquired by appropriation, indefinite rights of riparian proprietors, and unknown rights based on Spanish and Mexican grants. Making of water personal property and recognizing its appropriation for the purpose of sale has made it a speculative commodity. It is largely owned apart from the land, and the tiller of the soil is at the mercy of the owner of the stream.

I recently learned of a case where the litigation over a water right had occupied the courts for seven years. It stopped because the litigants were unable longer to pay lawyers' fees; but one of them informs me that, as soon as he can afford it, he will renew the contest. A single riparian proprietor has compelled the users of the stream on which he lives to pay him $250,000 for his consent to their using it. The users of water from Kings river have, all in all, paid hundreds of thousands of dollars to the riparian and other appropriators of that stream for the right to use its waters. Nor is their title thereto as yet secure. There are yet unused lands along that stream, and the riparian proprietors of these lands have a prior right to divert its waters.

In Utah, as in California, irrigation practice is immeasurably superior to irrigation law. Irrigated agriculture is the leading industry of the State, yet in no commonwealth is there greater uncertainty over titles to water. The comparative immunity from litigation which this State enjoys is not due to the excellence of its laws, but to the admirable influence of the Mormon church in promoting the peaceful settlement of controversies. In Utah, as in California, water is personal property. The appropriator who receives it as a free grant can, if he does not desire to use it, compel some one who does to pay him for the privilege of doing so. The laws which define rights and the provisions for determining these rights are inadequate. Priorities and amounts of appropriations have been in the past determined by the selectmen of each county, and, as streams often pass through several counties, there may be several sets of priorities and as many appropriations of the same supply. Until last year the State had no central bureau of administration, or even a State engineer, and the law which created this office made no provision for paying the salary of the man who fills it.

Colorado was the first State to provide for the supervision of streams. The administrative features of this law are admirable, and are the basis of the laws of several other States. Colorado has also been fortunate in her State engineers. They have all been earnest, conscientious officers, and several have been men of wide experience and great ability in their profession. The success which has attended the operation of the Colorado irrigation code has been largely due to the practical knowledge of the water commissioners and the tact and ability of the State engineers. They have had to deal, however, with defective titles to water. In this State, as in the two before referred to, the practice of irrigators is superior to the code which governs them. The fundamental weakness of the Colorado law lies in delaying public control of streams until after their waters have been disposed of.

Although the State engineer is the head of the irrigation system, he has no control whatever over the location of canals, or the character of the appropriation which govern the volume they may divert. The man best fitted to protect public interests has no voice in the disposal of this form of public property. Water rights are established by a clumsy, illogical, and expensive adjudication in court. The questions which should govern these rights are physical rather than legal, and it is no part of the training of a judge to know what a canal will carry, or what are the usages of irrigation. The adjudication of these rights under the Colorado law is simply a contest among those who have rights to establish. There is no State investigation of the necessities of irrigators, or of the truthfulness of the claims filed. If the interested parties agree among themselves to submit extravagant or fraudulent claims, they are usually successful. Such agreements are of frequent occurrence. They were the rule rather than the exception in all the early adjudications. As a result, the early decrees disposed of many times the stream's volume.

In 1884 and 1885, while acting as assistant State engineer of Colorado, I measured the ditches of northern Colorado on the streams which had been previously adjudicated. In my report of these measurements

I called attention to the discrepancy between the decreed appropriations and the actual carrying-capacity of these ditches and canals, in the following terms:

"So great was this in some instances that the result of the gagings and the decreed capacity seem to have no connection with each other. Ditches were met with having decreed capacities of two, three, and even five times the volume they were capable of carrying, ever have carried, or will probably ever need. Other ditches in the same district have decrees which fairly represent their actual needs. It needs no argument to show the worse than uselessness of these decrees as a guide to the water commissioner in the performance of his duties."

When these decrees were rendered, the majority of appropriators believed that rights for irrigation were limited to the lands already irrigated, and that, so long as used there, the actual volume stated in the decree cut very little figure. Hence, there was little solicitude on the part of late appropriators as to any danger arising out of excessive grants. Under the terms of these decrees each appropriator is entitled to a definite volume of water described in cubic feet per second, and to a continuous flow of this volume throughout the year.

Recent decisions of the Colorado supreme court have made water personal property, and recognized the right of the holders of these decreed rights to sell the entire volume granted. As a result, the owners of earlier rights are enlarging their ditches and extending them to water other lands, or, where this is not possible, are selling the surplus to other users. In this way water is being taken away from land long cultivated, and used to reclaim new land. Every attempt to do this, however, is contested. The truth is that irrigators have, in practice, been building up a system on one theory of water rights, while the courts have formulated a system based on another theory. They have now reached a point where one of the two must give way. If the doctrine laid down in the decisions of the Colorado supreme court are carried to their logical conclusion, it will transfer the ownership of a majority of the streams of northern Colorado to a few early appropriators, and compel a large proportion of the actual users of water to purchase from such owners the water they have heretofore had for nothing. That this is not an extreme statement is shown by the accompanying diagrams, which exhibit the relation between the mean monthly discharge and the decreed appropriations of the Poudre river and Boulder creek, two important streams of northern Colorado. The mean discharge of the Poudre, as given, was determined by taking an average of the mean monthly discharges for each month of the irrigation season for the years from 1890 to 1894 inclusive. It will be seen that, even in the month of

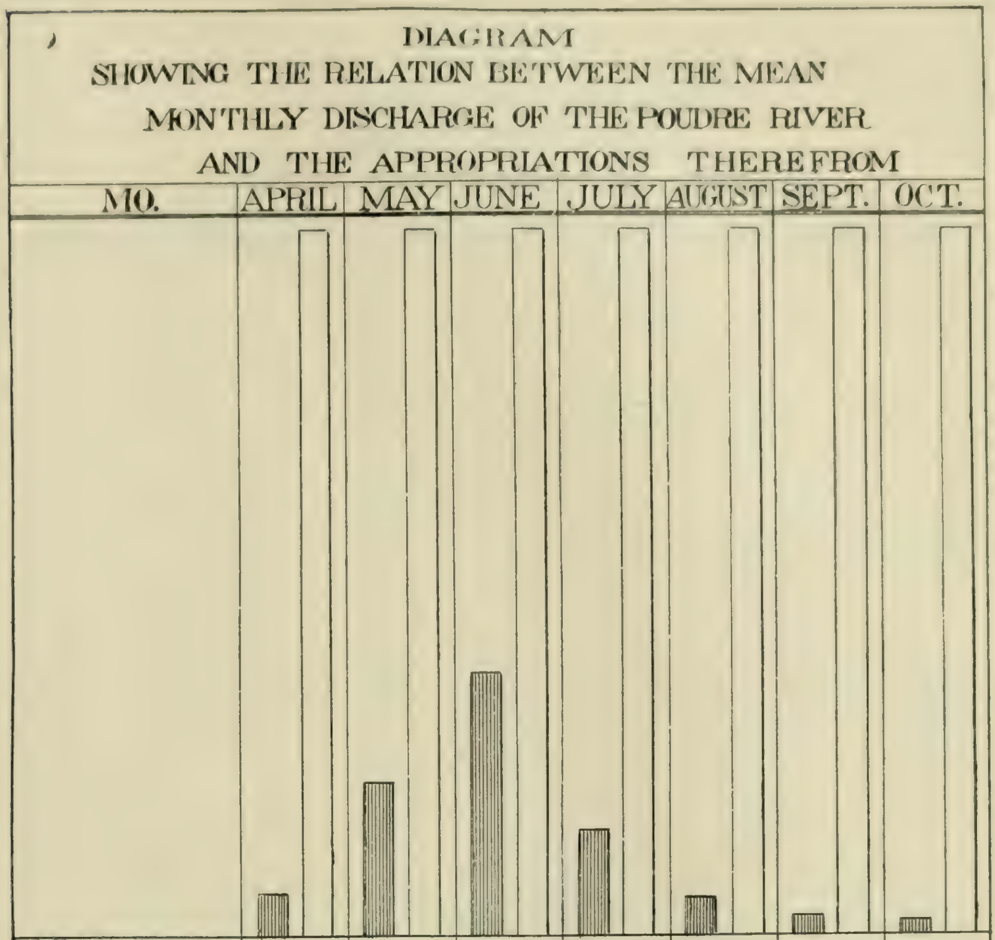


DIAGRAM
SHOWING THE RELATION BETWEEN THE MEAN
MONTHLY DISCHARGE OF THE POUDRE RIVER
AND THE APPROPRIATIONS THEREFROM

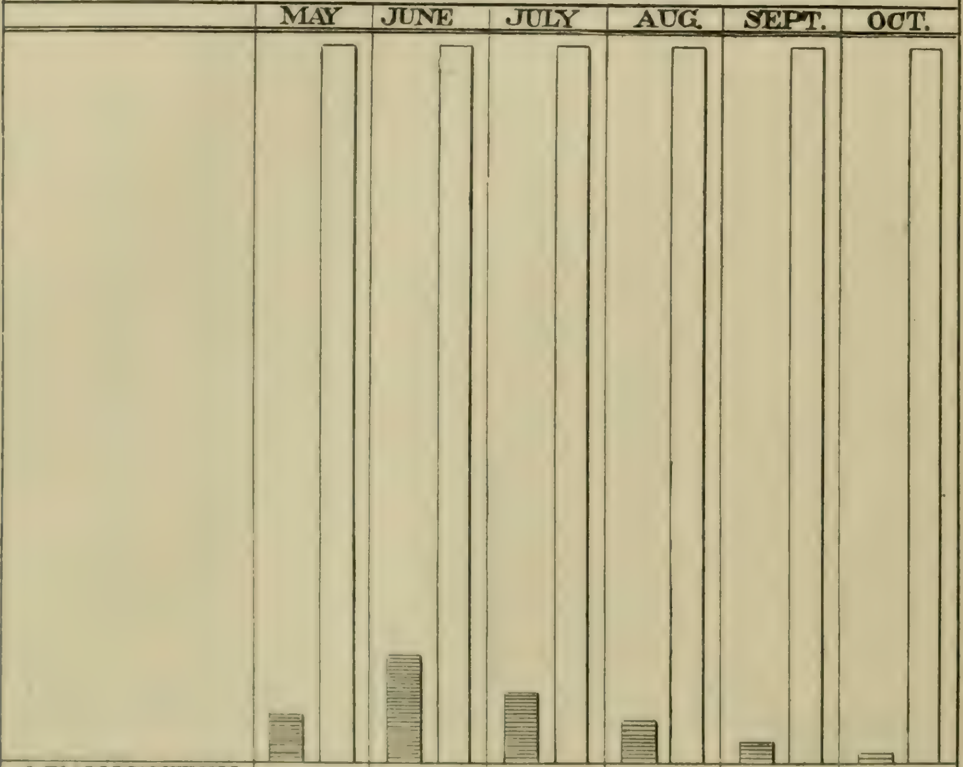
MO.	APRIL	MAY	JUNE	JULY	AUGUST	SEPT.	OCT.
MEAN MONTHLY DISCHARGE 1895 AND 1896	279	1012	1714	675	239	115	96
VOLUME OF EXCESS APPROPRIATION	4354	3621	2919	3958	4394	4518	4537
NUMBER OF APPROPRIATORS WITHOUT RIGHT TO WATER	91	63	50	70	93	98	98

☐ TOTAL VOLUME APPROPRIATED 4632.53 SEC-FT.
TOTAL NUMBER OF APPROPRIATORS 104
▥ MEAN MONTHLY DISCHARGE

greatest discharge, it is less than one-half the total volume of the appropriations, and that in two months of the irrigation season 98 of the 104 appropriators have no legal right to water. This is true only in case the doctrine of absolute ownership of the decreed volume shall be fully sustained. Thus far later appropriators have been able to use water, because no attempt has been made to enforce such right.

On Boulder creek the extravagant character of these decrees is even more strikingly exhibited. The mean monthly discharge for June, as shown by the State engineer's report, for the irrigation seasons of 1895 and 1896, was 383 second-feet; for October, 38 second-feet. The decreed appropriations are 2,659 second-feet. There are

DIAGRAM
SHOWING THE RELATION BETWEEN THE MEAN
MONTHLY DISCHARGE OF
BOULDER CREEK
AND THE APPROPRIATIONS THEREFROM



	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
MEAN MONTHLY DISCHARGE 1895 AND 1896	278	383	232	146	79	38
VOLUME OF EXCESS APPROPRIATION	2381	2276	2427	2513	2580	2621
NUMBER OF APPROPRIATORS WITHOUT RIGHT TO WATER	30	29	30	35	37	38

☐ TOTAL VOLUME APPROPRIATED 2658.74 SEC-FT.
TOTAL NUMBER OF APPROPRIATORS 40
▤ MEAN MO DISCHARGE

forty appropriators, and, from the earliest to the latest, all have been using water to the full extent of their needs during a considerable part of each season, and, except in years of unusual scarcity, during the entire season ; but this is because those having decreed rights have not utilized them.

When the stream carries one-third the decreed volume, water runs to waste under present conditions. But, if these surplus amounts are to be treated as personal property, they will, in time, be sold, and, when they are, about half of the users will have to buy a new right in flood-time, and more than three-fourths will have to look to the early priorities for permission to use water during the remainder of the season. The persons who will buy this water have been actual users of it for years. They will purchase it from those who have never used it at all, and whose sole claim to its possession is due to a defective procedure and an erroneous decision of the court in determining these rights. Whether or not such a state of affairs will ever come to pass cannot be foretold, but it is certainly true that the holders of these rights are working to bring it about. If the decrees are valid, they will in time be enforced ; if not, they ought one and all to be set aside. Thus far every attempt to enforce these surplus rights has resulted in litigation. The records of the supreme court of Colorado are burdened by appeal after appeal growing out of these excessive grants, and this will continue until either the entire system has been declared unconstitutional or late appropriators recognize that there is no hope of relief.

The management and disposal of streams is the greatest economic problem of the western half of the United States. On its solution depend the ultimate population and wealth of that region. It ought to represent the best thought and experience of the times. Instead of this, some of the laws now in force are a disgrace to a self-governing people. The history of other irrigated lands shows that certain institutions are necessary to the best results. Among these are the perpetual public ownership of streams, the limitations of rights to water to the right of use, and the restriction of this right to the place and purpose where originally acquired. Rights to water for irrigation should inhere in the land reclaimed, and be inseparable therefrom.

The efficient supervision of streams and just determination of rights to water require an intimate acquaintance with the laws and practices of irrigation. It can be effectively performed only by special tribunals created for that purpose. Courts are not such tribunals. Compelling every appropriator to institute a lawsuit to determine his right to water is a senseless makeshift.

Under a rational system the issuance of a certificate of appropriation is a purely ministerial act. There is nothing judicial about it. There is no more necessity for a court decree to establish a water right than for such a decree to confirm a land patent. Nor do the wisdom and efficiency of these reforms depend on the experience of other irrigated lands. For the past seven years they have been tested in the United States. They are all embodied in the irrigation code of Wyoming, and it is sufficient to say that, during the entire period of their operation, which had its beginning with the adoption of the State constitution, there has not been a single controversy or abuse due to the limitations imposed. On the contrary, the adoption of these restrictions ended scores of controversies and abuses. The only litigation over water rights which now occupies, or ever has occupied, the attention of the courts of that State or territory has resulted from attempts to establish or enforce surplus or speculative rights in streams.

There are two other provisions in European irrigation laws which, it is believed, will be found worthy of adoption. Under the present American system all appropriations of water are made in perpetuity, the appropriator receiving this as a free grant from the public. The subsequent supervision of the stream to protect this right is paid for by taxes. This is an illogical procedure. The public surrenders valuable property, for which it receives no direct return, and, in doing so, is compelled to shoulder a perpetual burden in the protection of that property. A better system would be to require each user of water to pay the State a rental therefor, these rentals to be very small, intended only to meet the expenses of supervision and prevent the salaries of water commissioners from becoming a burden on the public. A great value of this system would be that it would promote economy. The man who has to pay for what he gets will not be wasteful. It also places the doctrine of public ownership in a form which can be understood by all. That is not true at present. The man who get a free grant to the use of water in perpetuity comes in time to think he owns it, no matter what the laws or constitution may say.

The second change is that appropriations should not be made perpetual. They should be treated as franchises, and their operation restricted to a definite number of years. If rights to water were limited to fifty years, it would meet all the requirements of present development, and would enable the United States in the future to adjust their water laws to changing conditions. The present method may in time prove a serious obstacle to desirable, or even necessary, reforms.

THE ELECTRIC DEVELOPMENT OF HYDRAULIC POWER.

By F. C. Finkle.

A VERY significant movement, in the present age of extensive power applications, is the reversion of interest to the development and utilization of water-power. The statement was recently made in these pages* that the water-powers of Scotland might be made to generate electricity sufficient to operate all the railroads of that country.

Dr. Louis Bell has pointed out † that there are not less than 5,000,000 hydraulic horse power ready to be utilized in the United States when industry calls for it.

The Miesbach–Munich line stands as the pioneer in the necessary concomitant step—electrical transmission, but the demonstration there afforded was hardly complete from a practical view point, and it remained for the installation at Fresno, California, to accomplish the first long-distance commercial transmission. This delivery of electric power at 11,000 volts over a line 35 miles long was an advance of widely-recognized importance; indeed, California is peculiarly fruitful in similar examples—Pomona, San Bernardino, and Sacramento furnishing instances of power and light transmissions over distances varying from 13¾ to 28¾ miles.

This lends a proportionate value to the consideration of other installations in the same region, for, though these precedents of success have naturally their strongest influence in their own immediate neighborhood, the lessons are of very broad application. The last few years have witnessed a very great activity in the development of hydraulic power in the counties of San Bernardino and Los Angeles, the two leading counties of southern California. This activity still continues, and undoubtedly will continue until all the possibilities in this direction have been fully improved.

At first thought it may seem strange that this work should have been carried on to so enormous an extent in southern California at a time when industry was depressed throughout the United States. But, upon reflection, the causes which led to the inauguration and continuance of this movement become perfectly plain.

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* Prof. George Forbes, in the Engineering Magazine for October, 1897.

† In The Engineering Magazine for January, 1897.

Southern California, being the principal home of the citrus fruit industry in the United States, is rapidly becoming the region of dense population and small farms, as the high state of cultivation and large profits of orange- and lemon-growing make holdings of from five to ten acres ample for the support of a family. This has caused the rapid growth of cities and towns, where the demand for power for rapid transit and light is imperative, and the thick rural population makes suburban street-car service a necessity.

The following table gives, in round numbers, the population of a few of the principal cities of southern California, showing the phenomenal increase since 1880:

NAME OF CITY.	POPULATION.		
	1880.	1890.	1897.
Los Angeles	11,000	50,000	110,000
San Diego	2,500	16,000	25,000
Pasadena	400	4,800	15,000
San Bernardino	1,700	4,000	10,000
Riverside	1,300	4,900	9,000
Pomona	000	3,600	5,000
Redlands	000	1,900	4,500

In addition to the needs of her own population, southern California has to provide for the convenience and comfort of the army of tourists attracted to her coast and mountain resorts in summer and her interior valleys and cities in winter by the equable climate, beautiful scenery, and great variety of horticultural and floral wonders.

Another feature peculiar to this section is the irrigation problem. The gravity sources of water-supply available for irrigation were exhausted long ago, and, as new areas are brought under cultivation, it becomes necessary to pump water for irrigating them. Power is also required for the small manufacturing and mechanical work carried on in the different cities and towns, as well as for the beet sugar and canaigre industries, which are growing to large proportions.

To generate steam power for these various purposes there is no cheap fuel available, as coal has to be imported from England, costing, when landed, from $6.50 to $9.00 per ton, depending on the quality and on the rate of import duty, while the limited amount of fuel-oil obtained from wells in the vicinity of Los Angeles sells for from $1.00 to $1.50 per barrel, which is equal to good coal at from $4.00 to $6.00 per ton. As a result of these conditions the production of power costs from $70.00 to $100.00 per horse power annually, which high cost would have caused the development of the water powers much sooner, had it not been for the fact of their location at a considerable distance from the centers of population. As soon as long-distance electrical transmission became an accomplished fact, the remoteness of the water powers from the market was no longer an objection, and this field of development became a most profitable one.

The beginning was made by the construction of a plant in Mill Creek Cañon by the Redlands Electric Light and Power Company in 1893. The head works of this plant are illustrated on page 1017, which shows the upper end of the intake tunnel, and on page 1020, which shows the outlet of the same tunnel into the flume. The remainder of the system consists of about two miles of 36-inch riveted steel pipe having a fall of about 500 feet, the power house (an interior view of which is shown on page 1019), and the transmission lines to Redlands, Highland, Mentone, Colton, Riverside, and other outside points, where power is furnished for lighting, pumping water for irrigation, and operating the plant of the Union Ice Company at Mentone.

The capacity of the Redlands Electric Light and Power Company's plant is 800 h. p. at the lowest stage of the water in Mill creek, and the cost of the system was more than $75,000. It was built from the proceeds of bonds sold, and the revenues from power rentals have been sufficient to pay all expenses of operating and maintaining the plant in the best possible manner, interest and sinking fund for the bonded debt, and regular dividends on the stock.

Contemporaneously with the construction of the Redlands Company's plant the San Antonio Light and Power Company built a small plant in the San Antonio Cañon with a capacity of about 400 h. p. at the lowest stage of water in San Antonio creek. The output of this plant was immediately disposed of for lighting purposes in San Bernardino, Pomona, and Ontario, where a demand considerably in excess of the company's capacity existed, and this venture has proved as profitable as the Redlands enterprise.

The fact that these two undertakings were so successful, even during the financial distress of 1893, 1894, and 1895, coupled with the urgent demand for more power, caused preparations for the speedy development of all other water powers in the vicinity. The result was the organization of the Electric Power Company of Los Angeles, the Southern California Power Company, the Lytle Creek Light and Power Company, and the San Gabriel Electric Company, all of which began operations in the latter part of 1896 or the early part of 1897.

The Electric Power Company owns the upper portion of the water power of the San Gabriel river in Los Angeles county, and the San

Gabriel Electric Company the lower power on the same river. The Southern California Power Company owns the water power of the Santa Ana river, and the Lytle Creek Light and Power Company owns that of Lytle Creek, both of which streams are in San Bernardino county.

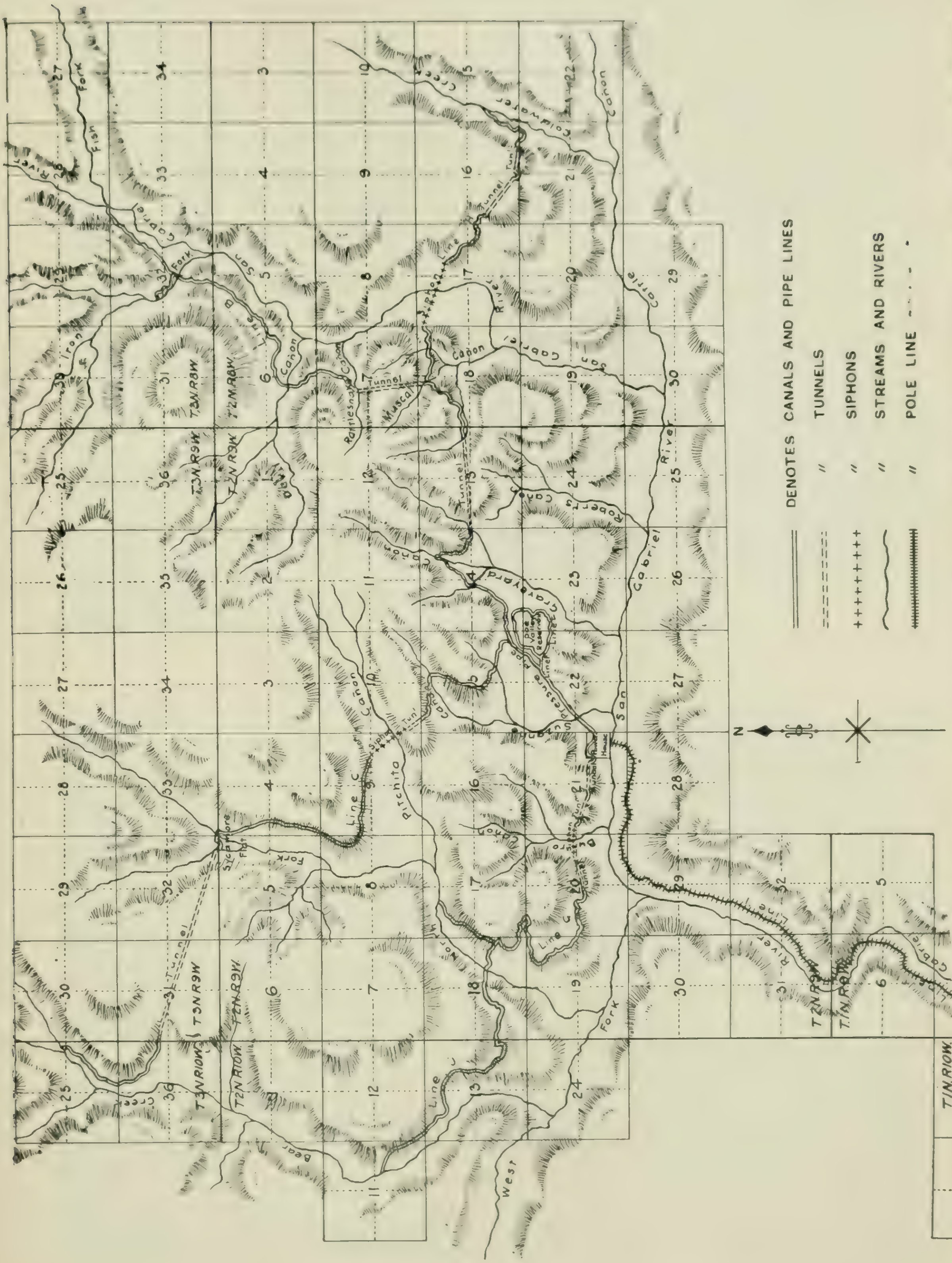
The plants of all these companies are now in course of construction, and at the present rate of progress they will be completed during 1898 or early in 1899. Therefore a brief description of the different projects, and a statement of the cost of each, will prove interesting at the present time. The location of each power and the site of the works in course of construction, together with those of the two powers already built and referred to above, are shown in the map on page 1022.

The Electric Power Company's project is shown on the opposite page in a sketch map taken from the company's right-of-way map across the San Gabriel forest reserve. Line "B" is the canal and aqueduct from the main San Gabriel river, Fish fork, and Iron fork, and will deliver the water of these streams to the head of the pressure pipe line at an elevation of 3,400 feet above sea-level. Line "H" is for a conduit to convey the water of Coldwater creek into the canal on line "B." Line "C" is for a canal and aqueduct from Bear creek and North fork to the head of the pressure pipe at the point of delivery of line "B."

The power house of the installation will be located below this point, on the bank of the river, at an elevation of 1,450 feet above sea-level, thus giving a fall of 1,950 feet for the water from the end of the canals to the power house in a horizontal distance of 7,600 feet. This distance will be covered by a 26-inch steel pressure pipe, through which the water will be delivered to the water motors in the power house under a static pressure of 825 pounds per square inch.

Lines "G" and "J" are for aqueducts to convey the lower waters of Bear creek and North fork to a point above the power house at an elevation of 2,050 feet above sea-level, thus giving a fall of 600 feet through another pressure pipe 14 inches in diameter and 1,300 feet in length.

In order to increase the capacity of the plant, a reservoir will be built at Doe Valley at an elevation of 2,850 feet above sea-level, and a steel pressure pipe laid from it to the power house. This pressure pipe will be 14 inches in diameter and 5,200 feet long, and will deliver the reservoir water to the water motors under a pressure of 600 pounds per square inch. The capacity of Doe Valley reservoir will be 3,418 acre-feet, and it will be filled through the canal on line "B" from the San Gabriel river at times when the flow exceeds the



MAP SHOWING RIGHTS OF WAY ASKED FOR POWER-DEVELOPMENT PURPOSES IN THE SAN GABRIEL FOREST RESERVE, LOS ANGELES CO., CAL.

A TUNNEL PORTAL.
Southern California Power Co.

capacity of the power plant. The gaugings of the river show that there is an abundance of water each year, during the rainy season, for filling many such reservoirs, and it is to be deplored that there are no other reservoir sites within the watershed. Line "I" is the route for a pole line from the power house to the south boundary of the San Gabriel forest reserve, and all the power will be transmitted over this route, from which different transmission lines will branch out to points where the power is to be delivered for use, the principal line being the one to Los Angeles, a distance of 33½ miles from the power house.

The cost of the Electric Power Company's plant will be approximately as follows :

Canal on line "B"	$115,000.00
Three steel pressure pipes	106,000.00
Canal on line "C"	127,000.00
Canals on lines "G" and "J"	27,000.00
Doe Valley reservoir	49,000.00
Power house and generating equipment complete	160,000.00
33½ miles of transmission line	75,000.00
Superintendence, surveys, roads, and incidentals	40,000.00
Total	$699,000.00

The power developed at the lowest stage of the river, using the reservoir only from six to eight hours each day to tide over the heavy load occasioned by street car and lighting service, will be as follows:

Lines "B" and "C," 3,400-foot level	4,550 H. P.
Lines "G" and "J," 2,050-foot level	550 H. P.
Doe Valley reservoir, 8 hours daily for 160 days	4,000 H. P.
Total	9,100 H. P.

This will be the capacity of the plant, not only during the 160 days when the reservoir is used, but also during the remaining 200

HEADWORKS, REDLANDS ELECTRIC-LIGHT AND POWER CO.

LOCATION OF DIVERTING DAM, SOUTHERN CALIFORNIA POWER CO.

days, since the river-flow is then sufficient to create this power without water from the reservoir.

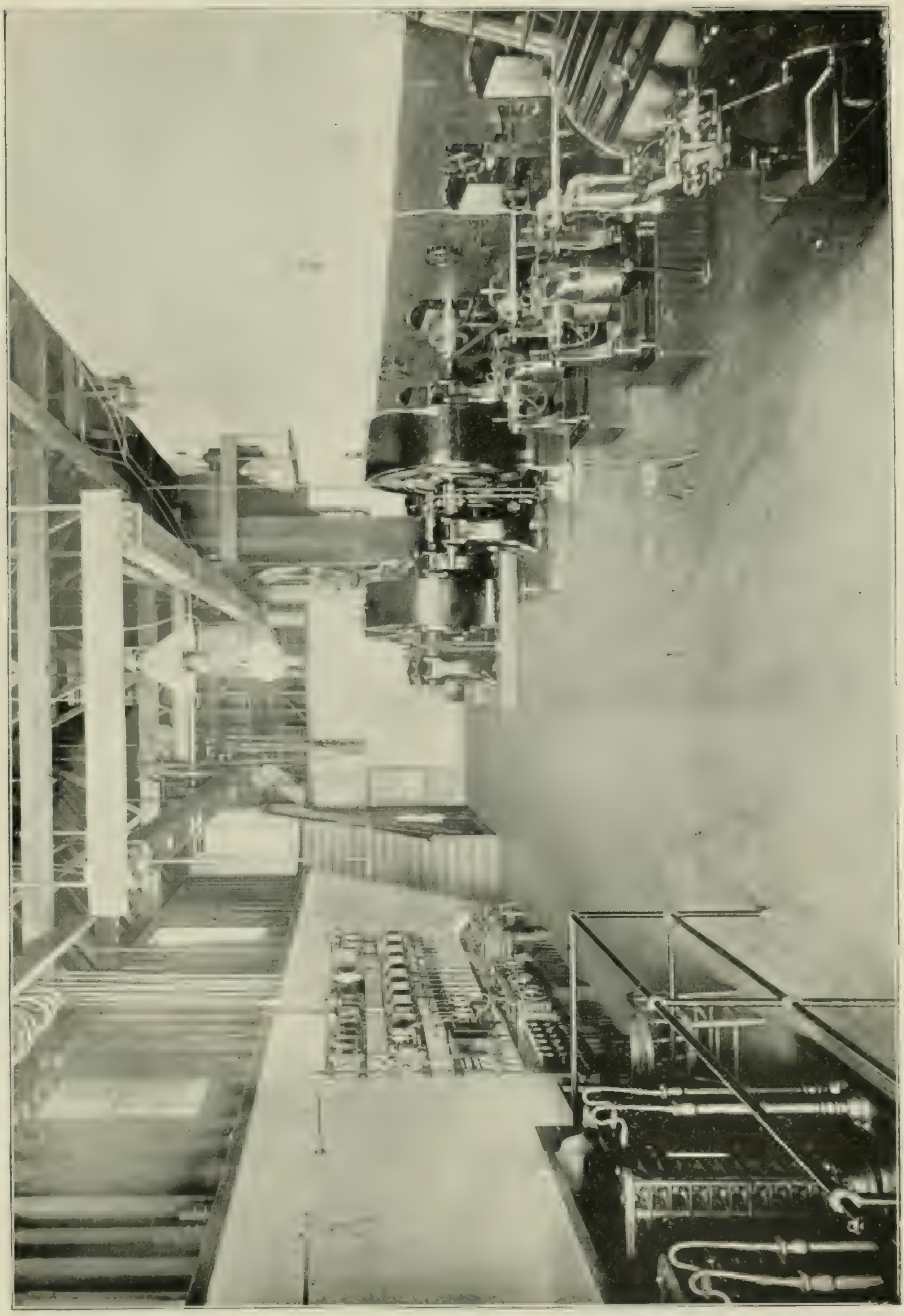
The conduits of the Electric Power Company which do not consist of steel pressure pipes will comprise cemented canals, flumes, tunnels, and cement pipes. The sections on pages 1023-1026, illustrate the plan of these conduits. These plans, showing the manner in which aqueducts, both for power and irrigation, are generally constructed in southern California, are interesting.

At the present writing the Electric Power Company has completed two and one-half miles of the conduits above described, surveyed the lines for all the remainder, and prepared most of the roads and trails necessary to complete the construction of the plant.

LYTLE CREEK AT MILLER'S NARROWS, IN SUMMER.

The Lytle Creek Light and Power Company is preparing to divert Lytle creek at Miller's Narrows, this being the point on the stream where the greatest flow is found in the dry season. A view of the stream at this point during the dry season, or period of low water, is shown by the illustration on this page.

Diversion will be effected by a tunnel through the point, or spur, of the mountain at Miller's Narrows, to tap the stream immediately above the Narrows. This tunnel is now being constructed. From the mouth of this intake tunnel the canal is to be built along the side of the mountain bordering Lytle Creek Cañon on the east. It



POWER-HOUSE OF THE REDLANDS ELECTRIC LIGHT AND POWER COMPANY.

OUTLET OF TUNNEL, AND SANDBOX, REDLANDS, CAL.

will consist of cemented canal, wooden stave pipe, and tunnels, its total length being 20,168 feet to the point, where the water will drop down to the power house, through a 26-inch steel pipe 1,460 feet long, a vertical distance of 500 feet. The location of a considerable portion of the conduit line is shown in the illustration below which is from a photograph taken after the line had been surveyed and the route partly cleared.

In addition to using the ordinary summer flow for power, as above indicated, the company intends to store surplus water in winter by building a dam 90 feet high at Miller's Narrows. Such a dam will impound sufficient water to give a continuous discharge of 14 second-

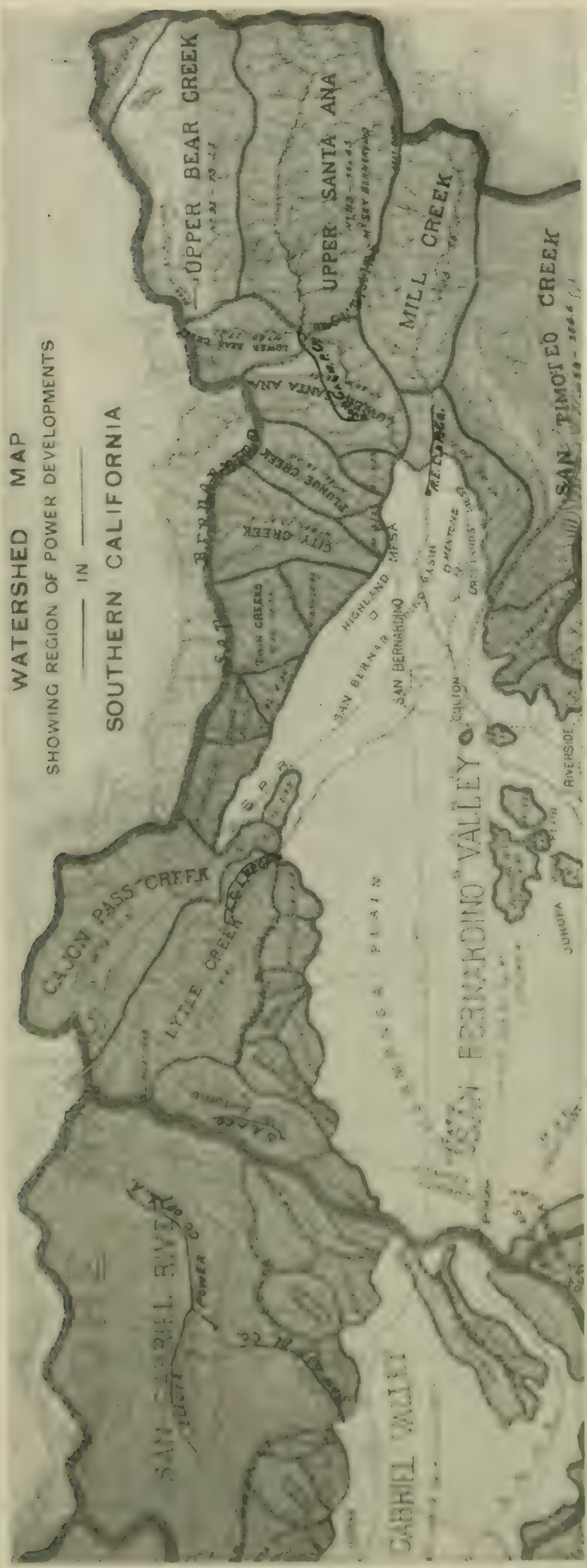
CANAL LINE OF LYTLE CREEK LIGHT AND POWER CO.

feet for 200 days each year, and there is a large flow during some of the winter months from which the reservoir can easily be filled without depriving the power plant of any of the water required by it during this time. The estimated cost of the system of the Lytle Creek Light and Power Company, without the reservoir, is as follows :

Intake tunnel	$ 1,500.00
Canal to head of pressure pipe	56,000.00
26-inch pressure pipe	8,000.00
Power house and generating equipment complete	32,000.00
Transmission lines	27,000.00
Surveys, superintendence, incidentals, etc.	10,000.00
Total	$144,500.00

SITE OF HEADWORKS, SOUTHERN CALIFORNIA POWER CO.

The result of this expenditure, taking the minimum flow of the stream, will be 1,300 h. p. By building the impounding dam at Miller's Narrows the total cost will be increased to $235,000 and the power to 2,050 h. p. The company's intention is to build the works without the reservoir at once, and, as soon as satisfactory contracts to sell the water for irrigation purposes can be obtained, to proceed with the construction of the dam. At present work is being prosecuted on the intake tunnel and the plans and specifications are being prepared for the remainder of the plant.

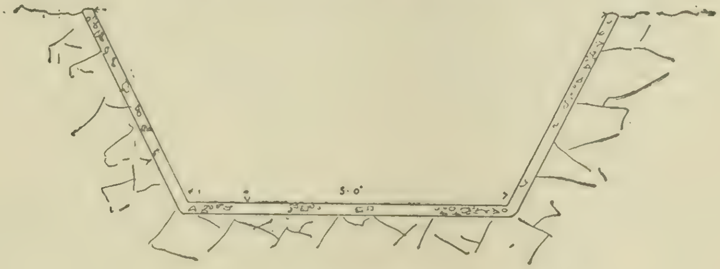


The intended point of diversion of the Southern California Power Company is on the Santa Ana river at the junction with Bear creek, its principal tributary. This point is shown in the illustration on page 1017, which affords an idea not only of the volume of water available in the stream, but also of the topography of the banks and the surrounding country. The particular site selected in this instance, as will be immediately apparent, is well adapted to the purpose, being narrow, with steep, rocky cliffs on both sides. From here to the head of the pressure pipe a conduit 14,650 feet in length has been located, to consist of 10,780 feet of solid rock tunnel and 3,870 feet of flume. The pressure pipes from the end of this conduit to the power house will be 2,200 feet in length, and will consist of two 30-inch lap-welded steel pipes.

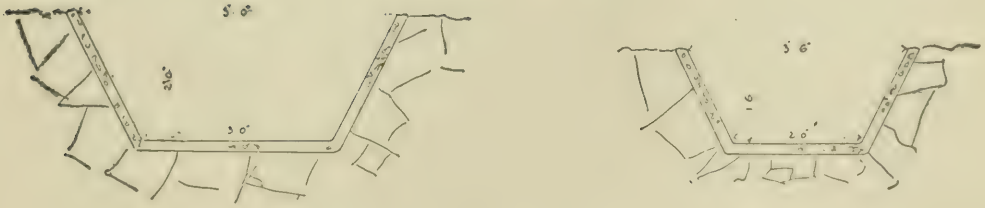
The fall through the pressure pipes from the end of the conduit to the power house is 750 feet, which will give a static pressure of 317 pounds per square inch at the water motors, after deducting for loss due to friction in the pressure pipes.

The water supply for the plant of the Southern California Power Company will be derived from the natural flow of the Santa Ana river and Bear creek and from the water conserved by the famous Bear Valley reservoir, at the head of Bear creek. The water is used for irrigation at Redlands, Highland, Perris, and Allessandro, being diverted from the Santa Ana river below the power house of the company; and the quantity supplied to the places named can never be less than 60 second-feet, according to existing contracts, any deficiency in the stream below this amount being made up from the reservoir. It is estimated, however, that, on account of the various losses occurring while carrying the water long distances, 80 second-feet are necessary at the location of the power company, in order to make the delivery of the 60 feet possible at the points where it is used for irrigation. Hence the minimum supply of the company is placed at 80 second-feet, which insures a marketable power from the plant of 4,500 h. p.

The cost of the Southern California Power Company's plant is estimated at $900,000, including $400,000 already expended for land, franchises, water rights, rights of way, and preliminary work, and $150,000 expended in constructing the conduit and purchasing materials for the plant. The remaining $350,000 will be required for the completion of the conduit, the construction of the two 30-inch pressure pipes,—for which the J. D. Hooker Company, of Los Angeles, already has the contract,—the construction of the power house and supplying it with generating machinery, and the completion of the



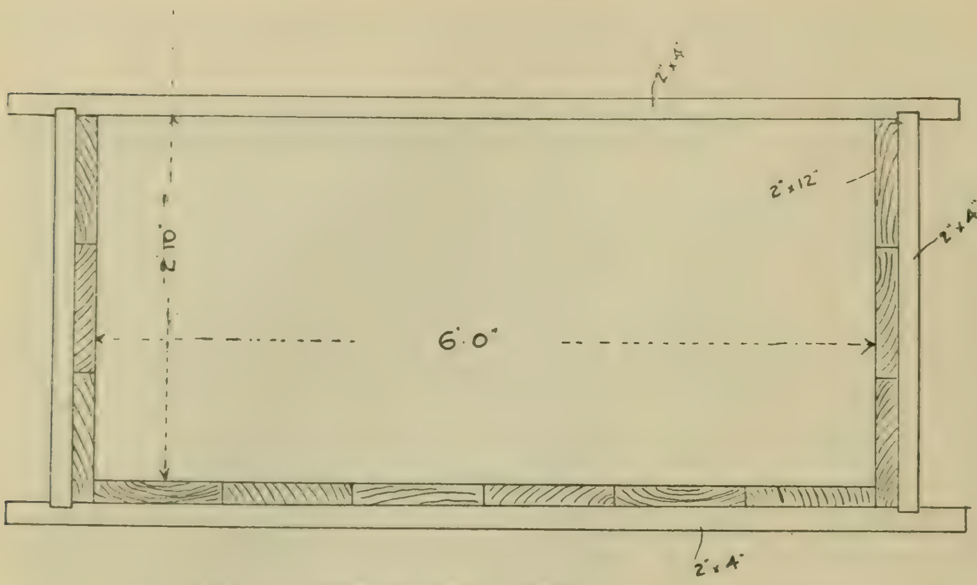
Cross Section of Large Canal.



Cross Section of Medium Canals

Cross Section of Small Canal.

DETAILS OF CANALS, ELECTRIC POWER CO. OF LOS ANGELES.



DETAILS OF FLUMES, ELECTRIC POWER CO. OF LOS ANGELES.

transmission lines with the necessary step-up and step-down current transformers.

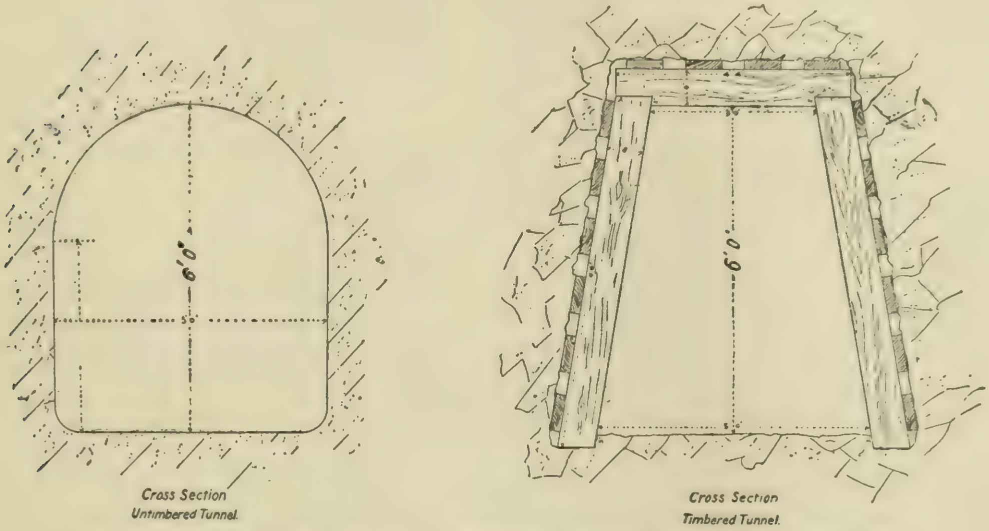
The construction of this plant is well under way at the present time, nearly half the work having been completed, and, as the company has contracts calling for the delivery of power June 1, 1898, it is to be presumed that the system will be in operation by that time.

The intake of the San Gabriel Electric Company is on the San Gabriel river, about three miles below the power house site of the Electric Power Company of Los Angeles, and at an elevation of 1,150 feet above sea-level. The rights to the intervening fall of 300 feet belong to the latter company, and a supplementary plant will be constructed to utilize it, as soon as the larger one, already described, has been completed.

The San Gabriel Company's intake is by means of a tunnel or subterranean gallery, which will tap the river about 18 feet below the stream bed ; and it is also planned to build a submerged dam to force up any underflow which may exist at this point. From the outlet of the intake tunnel the conduit will traverse the side of the mountain along the south-easterly bank of the river, gradually rising above the stream, until the mouth of the San Gabriel Cañon is reached, where a drop of 400 feet is obtained. The power house will be located at the foot of this drop, and the water conducted down into it from the end of the conduit through a 36-inch pressure pipe. The conduit from the intake to the head of the pressure pipe will be about seven miles long, over four miles of it being tunnel and the remainder 48-inch wooden stave pipe. The tunnels will be lined with cement throughout, and the pipes will be made of 2-inch California redwood lumber and banded with ¾ inch round steel hoops.

The company has let the contracts for the completion of the plant, and the work is about half finished at this writing. The contract prices have not been made public, but the approximate cost will be as follows:

Intake tunnel	$ 15,000.00
Submerged dam	10,000.00
Conduit and pressure pipe	150,000.00
Power house and generating equipment	40,000.00
Transmission lines	40,000.00
Surveys, superintendence, and incidentals	20,000.00
Total	$275,000.00



Cross Section Untimbered Tunnel.

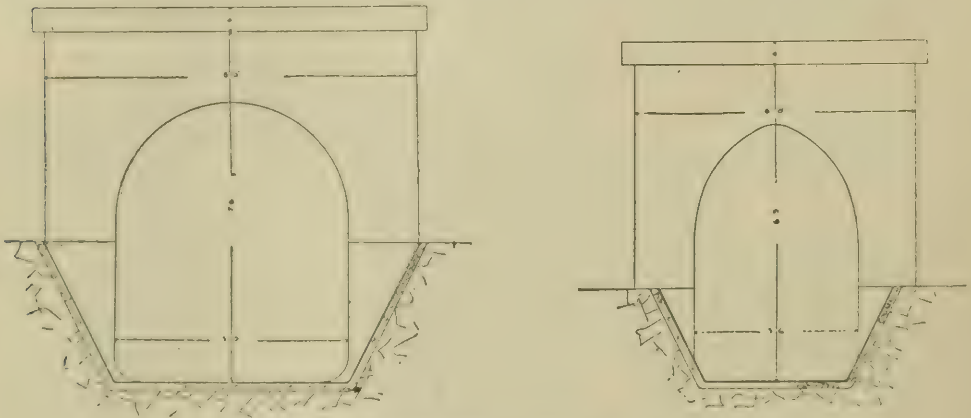
Cross Section Timbered Tunnel.

DETAILS OF LARGE TUNNELS, ELECTRIC POWER CO. OF LOS ANGELES.

The San Gabriel Electric Company possesses the right to use only the normal flow of the river at *its* point of diversion. The stored and salvage waters of the Electric Power Company, of Los Angeles, being the exclusive property of that company, will be carried out of the cañon over a route of its own, and sold for irrigation. The minimum flow of the San Gabriel river, as reported by the hydrographic division of the United States geological survey in 1896, was 10 second-feet below the intake of the San Gabriel Company. This makes the capacity of the company's plant about 500 theoretical h. p., or about 350 marketable h. p. The company is building its plant of a much larger capacity, however, which indicates that it intends to develop a greater power during a portion of the year, when the flow of the river is above the minimum.

This completes the list of water powers now incorporated and in course of construction in southern California. Surveys are now being made for other projects on the Whitewater river, the Santa Ana river above the Southern California Power Company's location, and Mill creek above the plant of the Redlands Electric Light and Power Company. If surveys and estimates shall demonstrate that these are practicable, in spite of their greater distance from the market and the greater inaccessibility of the country where they are projected, they will, without doubt, be constructed, as the plants now in course of construction will not be able to satisfy the demand for power in southern California.

Meanwhile engineers will be interested in seeing the powers now under way put into operation, on account of the interesting features embraced by some of them. The great pressure at the water motors —825 pounds per square inch—will make the plant of the Electric Power Company of Los Angeles a notable one, when completed, and the long transmission of the Southern California Power Company— about 80 miles with a voltage of 33,000—will be something decidedly novel, as the longest commercial electric-power transmission at the present time is that of 35 miles at Fresno, California.



DETAILS OF PORTALS, ELECTRIC POWER CO. OF LOS ANGELES.

In this connection it may be stated that the climate of southern California, on account of its extreme dryness and freedom from electrical storms, is well adapted to long electrical transmissions by means of high voltages.

REVIEW OF THE ENGINEERING PRESS

Breakwater Construction.

A PAPER recently read before the Engineers' Club of Philadelphia by Mr. Louis Y. Schermerhorn contains much valuable information regarding breakwaters on the American coast in particular, as well as some general facts regarding wave-power and the effect of ice and water-pressure upon such structures.

A distinction must be clearly made between breakwaters and jetties, piers, and other similar structures, a breakwater differing from the other constructions in that it is essentially a wave-breaker, intended to resist and check wave-action and provide a protected harbor or roadstead.

In Mr. Schermerhorn's paper especial attention is given to the Delaware breakwater, because it has served as the prototype of all other accomplished or proposed random-stone breakwater construction on the coast of the United States.

Experience upon American breakwaters has determined that the depth to which energetic wave-action extends is about twelve or fifteen feet, and this depth is generally assumed as the approximate plane of rest for the material used. The increased exposure of European breakwaters, and the height of ocean waves impressed upon their works, lowers the plane of rest to a depth of about twenty feet, and the necessary allowance for the increasted tidal range also affects the practice in Europe, rendering the precedents there obtained unsuited for American work.

The term plane of rest is not intended to imply that there is a well-defined line below which no wave-action extends; it rather indicates a depth at which the disturbing effect of the waves has been so reduced that it is no longer able to move the special stones constituting the slopes at that depth.

The slopes of a random-stone breakwater may be divided into: (1) that part of the sea face which is below the plane of rest; (2) that part which is between the plane of rest and the surface of the water; and (3) the part above the surface of the water. On the harbor side only two divisions need consideration,—that below and that above the water surface. Below the plane of rest the slope becomes practically that of the angle of repose of the material between the plane of rest and the surface of the water the slope will be formed by wave-action, modified by the dimensions of the stone; while above the surface of the water the slopes on either side will be artificial, and will depend upon the nature of construction employed.

The flattest slopes on the sea-side of the Delaware breakwater are about 1 on 3, which is much steeper than is used in Europe, the active sea slopes of the Portland, Plymouth, and Cherbourg breakwaters varying from 1 on 4 to 1 on 8; while the Delaware breakwater is not exposed to the force of seas such as are thrown upon the European works, it is probable that its slopes are more nearly in equilibrium with the forces impressed upon them than are those in the flatter designs.

Since the maximum economy in construction is obtained when the slopes and cross-section are such as to produce equilibrium with the external forces, it is possible to adopt such a method of construction as will cause the slopes to be determined experimentally in each case, by following a certain order of procedure.

To accomplish this result the random stone is first deposited in an area conforming strictly to the space selected for the assumed plane of rest, the material thus being forced to assume the steeper angle of repose belonging to this portion of the work. The second section, consisting of the mass between the plane of rest and the base of the superstructure, is carefully deposited within the area of the base of the superstructure, putting the larger stone on the sea-side, and, as this portion is within the influence of the disturbing action of the waves, it naturally assumes such slopes as place it in actual equilibrium with the wave forces impressed upon it. If, for any reason, too steep slopes have been assumed, the action of the sea corrects the error. After thorough settling has occurred, the superstructure may then be built in any desired manner, usually in the form of a rough, heavy wall built of large stone, bonded together from each side, with the space between filled with smaller material.

This method, which has been developed and applied by Major C. W. Raymond, U. S. A., is that adopted in the new Delaware breakwater, and is also proposed for the new breakwater to be constructed at San Pedro, in southern California.

Mr. Schermerhorn's paper contains much interesting information upon the force and height of waves, gathered from various sources. In the British seas the maximum heights range from 27 to 30 feet; in mid-Atlantic as high as 43 feet; while at Cape Horn waves as high as 50 feet have been observed. The pressures, as measured by marine dynamometers, have reached 6,000 pounds per square foot in the North Atlantic, and 3,000 pounds in the German ocean, while from the effects produced in the destruction of the beacon at the mouth of the Loire it is estimated that the pressures per square foot there ranged between 4,800 and 6,000 pounds. These figures, however, give but little information as to the force of impact, this varying as the cube of the height of the waves; but it has been computed that for waves 15 feet high the energy of impact for each foot in length of wave crest is about 21,000 foot-pounds, and, under certain conditions, much more.

From such considerations, and from comparison with existing works which have stood the force of the sea successfully, the general dimensions of a proposed section can be deduced, after which the method above given, modified in connection with local conditions and materials, may be employed with confidence in the important and difficult work of breakwater design.

The Engineer in the Navy.

THE "line and staff" dispute, which has been pending so long in the United States Navy seems likely to find its permanent solution in the arrangement originally due very largely to Professor Hollis, and included in the report of the Naval Personnel Board submitted by Assistant Secretary of the Navy Theodore Roosevelt.

The substance of the arrangement recommended in this report is that both the line and the staff officer are to be wiped out of existence, as such, and that a new corps is to be substituted, consisting of men who are both sailors and engineers combined.

While this is apparently a graceful way of yielding to the demands of the staff officers for positive rank and an undivided responsibility, and certainly lets the advocates of the inherent superiority of the line down quite easily, it is really a change, the magnitude and importance of which is hardly realized by some who have commented upon it; least of all by the line officers themselves.

When we consider the great changes and advances which have been made in the construction and handling of the modern ship of war during the past few years and the transformation which has been made from the old time vessel into the present fighting machine we must be prepared to see as a result of the adoption of the report of the Naval Personnel Board that in a few years the officers of the United States Navy will all be engineers, possessing indeed such a knowledge of navigation as is needed for practical use, but above all men familiar with and devoted to engineering as applied to naval warfare, and altogether freed from the fetish of unnecessary official etiquette which has been so much in evidence in the past.

That some such solution of the problem must come, we foreshadowed in these columns several years ago, and it will not be out of place to quote at the present time what was then written upon this subject.

"A modern warship is probably the greatest aggregation of the work of the engineer which can be found anywhere within the same limits of space, and surely methods of organization and discipline should keep pace with the transformations in construction and operation. A fighting machine must be *fought* by engineers as well as built by engineers, and it may be that the officers of the line will awake to the realization of their false position only to find that there is no further occasion for their existence at all."

Humidity in House-Heating.

ONE of the noticeable features of American houses to those foreigners who chance to be in the United States in winter is the high temperature which is thought necessary in dwellings and public buildings, and with this the excessive dryness of the air is also a matter of observation and comment.

The injurious effects of this dryness, and the relation which it bears to the important subjects of warming and ventilation, form the subject of a paper recently read before the American Public Health Association by Dr. Henry Barnes, and abstracted in *Heating and Ventilation.*

Except in certain localities noted for their dry climate, the mean relative humidity of the air in the United States lies between 60 and 70 per cent., according to the well-known meteorological scale in which zero means entire absence of moisture and 100 corresponds to complete saturation. This proportion of moisture is, in general, better adapted for comfort and health than either a higher or lower degree of humidity, and, if such a percentage were maintained indoors during the winter, it would doubtless be much better for all concerned than the practice of supplying large volumes of hot dry air, or the presence in the rooms of extensive surfaces of heated metal.

From a number of tests of the air in various buildings, heated by steam, hot air, and hot water, the mean relative humidity was found to be only about 31 per cent., while at the same time that of the outside air averaged more than 70, this difference being entirely due to the fact that with the heating no attempt had been made to supply the additional moisture required to maintain the relative humidity at the higher temperature.

The action of such dry air upon any object containing moisture, such as the human body, is clearly shown by exposing a wet-bulb thermometer to the air. The avidity with which the dry air absorbs the moisture causes the mercury to fall very rapidly, and maintains it at a temperature of nearly 20° F. lower than that indicated by the dry-bulb thermometer. It is this refrigeration, due to the rapid and continuous evaporation from all parts of the body, which produces the chilly sensation at the slightest draft or current of air in the hot, but dry, rooms of many houses; while, if the normal degree of moisture were present, the temperature indicated by the ordinary dry-bulb thermometer would also be the sensible temperature perceived by the occupants.

Dr. Barnes shows how inadequate the ordinary methods for supplying moisture are, even when used, and it is far more frequently the case to find that the water-pans and evaporators attached to the hot-air furnaces are not used at all. In some cases a pan of water is placed on a radiator, or a porous pot hung in front of a register, but such cases are the exception, and it is the rule in American houses to ignore the matter almost altogether, and let the air become as dry as the heat will make it.

By computing the volume of air passing through an ordinary hot-air furnace, Dr. Barnes shows that the ordinary methods of supplying moisture are by no means equal to the demand, as nearly fifty gallons of water should be supplied to a furnace in twenty-four hours to maintain the relative humidity at 65. He describes a simple arrangement of metal box containing suspended sheets of cotton-felting with the lower edges dipped in water, furnishing about ten square feet of evaporating surface, and this placed so that the hot air passed through it keeps the humidity in the room at about 53, and makes a temperature of 65° F. comfortable.

There is little doubt that the maintenance of the proper degree of humidity would prevent much of the illness prevalent in winter, especially colds, coughs, and throat troubles, and it is very probable that the catarrhal affections so common in winter, and the frequent failure of the vocal organs, may also be the result of the parching effect produced by breathing an excessively dry air.

As many new buildings are now provided with complete ventilating systems in connection with the warming apparatus, it is not unlikely that some form of humidifier may be also attached, which will maintain the correct relative degree of humidity, and thus preserve both the health of the occupants and the joints of the furniture from the injurious action of the parched air.

Compressed Air Explosions.

SEVERAL months ago some account was given in these columns of serious, and even fatal, explosions of mingled air and vapor of lubricating oil in air-compressors in Germany, and now, in an interesting communication to the *American Machinist*, a correspondent describes some similar explosions which have occurred in the United States. Two of the explosions described took place under circumstances that prevented their exact conditions from being observed with much accuracy; as the writer remarks: "For the succeeding few seconds we were all too busy dodging trapdoors and parts of machines with which the atmosphere was filled to take accurate observations; so the cause remained a mystery until the third explosion."

This third explosion occurred in a stretch of horizontal pipe, at each end of which there was a short vertical riser, the whole forming a portion of a connection from a reservoir of compressed air to a point of utilization. This arrangement of piping formed a sort of trap in which any liquid would collect, and, when a valve at the end nearest the reservoir was suddenly opened, admitting a pressure of about 1,700 pounds, a frightful explosion took place. In the words of the writer: "It was much louder than the air explosions which I had previously heard, being sharper and more deafening in character. It was, moreover, accompanied by a great burst of flame, which, together with the concussion, left one dazed for a minute or more."

As these pipes had been tested to 6,000 pounds and had been in daily use at over 2,000 pounds' pressure, it was certainly a higher pressure than the 1,700 pounds in the reservoir which caused the disaster, and the presence of the flame, and the deposit of soot which was afterwards found on the ruptured portion, indicated the nature of the explosion very clearly.

The writer of the communication explains the cause of the explosion in a lucid and practical manner.

"We had two closed valves connected by a loop of pipe containing oil and air at atmospheric pressure. One valve is opened, letting high-pressure cool air into the space. The incoming air stirs up the oil, catches it in the narrow pipe, and drives it, like a plunger, down the tube. The air originally contained in the pipe is compressed by the incoming air, just as if it were acted upon by a piston. Its temperature is almost instantly raised to that corresponding to a red heat or above. The small amount of oil present is vaporized and fired as prettily as though Messrs. Hornsby & Ackroyd had superintended the performance."

The conditions which exist in cases like these are not always as accurately observed or as well described, but there is no doubt that the presence of oil, either in the form of vapor or of finely-divided spray, may become a source of danger in compressed-air plants, and this too, not only in the compressor itself, but also in the connections. That such dangers may be avoided by care both in designing and operating the plant is apparent, and one reason for giving the conditions of such explosions wide publicity is to aid in the avoidance of their repetition.

In this connection there is one important feature which must not be overlooked. Increased pressure usually lowers the temperature of ignition or explosion of a gas or gaseous mixture, so that a mixture which would be exceedingly difficult of ignition at atmospheric pressure will explode under pressure at a much lower heat. This is clearly shown in the case of acetylene, which is difficult of explosion at pressures below two atmospheres, but which may readily be made to explode at higher pressures.

At pressures of ten or twelve atmospheres the increased ease of ignition is one of the factors that must be considered, and additional care is necessary in cooling all parts of the apparatus; while the use of a minimum quantity of oil and a thorough draining of all parts are features which should not be neglected.

Tests of Cast-Iron Columns.

A VERY important series of tests of cast-iron columns has recently been completed at Phœnixville, Pa., by the department of buildings of New York city, and from an extensive account given in *Engineering News* we make some abstracts.

Three sets of columns were tested to destruction in the hydraulic testing machine of the Phœnix Bridge Company, these being respectively 15 feet 10¼ inches long by 15 inches in diameter; 13 feet 4 inches long by 8 inches in diameter; and 10 feet long by 6 inches in diameter; the thicknesses varying from 1 11-16 inches to ⅝ of an inch. In the first group were two columns taken from the "Ireland Building," which collapsed in the summer of 1895 in New York, and four similar ones cast for the purpose of the test, while the second and third groups each consisted of two columns of kinds used in regular building construction, made by well known firms, and were fair samples, coming within the provisions of the law.

The data of the tests are tabulated in the paper referred to, and some of the salient features may be especially noted. With but two exceptions the thickness varied materially in different portions of the same column, so that in one instance the metal on one side was 1¼ inches thick, and on the other only ⅝ of an inch; and, although this was an extreme case, there was a decided irregularity of thickness, which probably affected the strength materially. All of the 15-inch columns were broken, except one, which was nearly uniform in thickness, and which remained intact at the maximum pressure of the testing machine,—a load of more than 2,082,000 pounds, or more than 40,000 pounds per square inch of area. The breaking load of the others of this group varied from 25,000 to 30,000 pounds per square inch, the variations being apparently due to the presence of cinder, foundry dirt, chaplets, and blow-holes. The smaller columns were all broken with loads ranging from 22,000 to 32,000 pounds per square inch of area.

According to the building law of the city of New York, the strength of all columns and posts is to be computed by Gorden's formula, using a coefficient of 80,000, and a factor of safety of five for cast iron. The application of Gordon's formula, under these conditions, to the columns tested shows that the 15-inch columns should have a breaking strength of 57,000 pounds per square inch, instead of which it actually ranged from 25,000 to 40,000 pounds; while for the 6- and 8-inch columns the breaking strength by the formula should be 40,000 pounds per square inch, instead of 32,000 to 22,000 pounds, as shown by the tests.

Had these columns, therefore, been loaded as heavily as the law permits, the factor of safety in some cases would have been only a little more than 2, instead of 5 as intended. Judging from the physical description given of the columns tested, this discrepancy is much more likely to be due to the defects in the castings than to the inaccuracy of the formula, and apparently a requirement for better material and more-carefully-made castings would raise the strength nearly, if not quite, to that indicated by computation.

An interesting feature of the paper is the description of the calibration of the Phœnixville testing machine by comparison with the Emery testing machine in the United States Arsenal at Watertown, Mass. This calibration was effected by testing a special soft-steel Phœnix column, first at Watertown and then at Phœnixville, using a roller extensimeter reading to 0.0001 inch, the conditions being reproduced as nearly as possible in the second test, and the same extensimeter being used. The result showed the gage readings of the Phœnix machine to be from 15 to 17 per cent. higher than the actual values, this being due to friction of the machine and possibly to gage error. By using this correction, the tests at Phœnixville are made comparable with those at Watertown, with a possible error of about 3 per cent.

New York Building Laws.

In several recent issues of the *Engineering Record* the weak points in the New York building law are pointed out, and the subject illustrates very well how the growth of a city and the introduction of new methods may render many points in once adequate ordinances quite obsolete or insufficient. When the existing building laws were enacted, the system of constructing business buildings was altogether different from that now in use. The limit of height was five to six stories; light brick walls, timber columns and floors, and moderate loads were the rule; the modern tall building, with its steel skeleton and deep foundations, was unknown, and any attempt to regulate the practice in modern building work by rules based upon the older conditions must necessarily be defective.

It is doubtless true that the modern great buildings of New York are well designed and properly-built, not because the ordinances have required proper work, but because the engineers and architects in charge have attended to it on their own and their client's account. This, however, is not a good state of affairs, and should not be depended upon.

"Good architects, good engineers and good builders have in many cases done what the building ordinance has failed to require them to do; but that is not enough. Well-intentioned men are sometimes not well qualified to do those things which they may desire to do, and such things as indifferent and careless, not to say unscrupulous, building are not unknown."

Most of the criticisms of the building ordinance of New York are naturally made on the score of omission,—a thing to be expected when the practice has outgrown the legislation,—and a few of these defective features are worthy of mention. In the question of the quality of materials employed, vague terms, such as "the best material, made in the best manner," should be replaced by specific terms of precise, legal, and scientific meaning, about which no difference of opinion could exist. The methods of testing and describing materials of construction are well enough known to permit of accurate specification, and materials of lower grades could be clearly specified as permissible for those purposes for which they are fitted, and no hardship wrought and no danger incurred. The present law includes some attempts to use scientific formulas for certain limited purposes, but so indefinitely as to permit almost any proportions to be deduced.

Working stresses permitted on iron steel, masonry, timbers, etc., need careful revision and extension, in accordance with the advance of knowledge concerning the behavior of the materials and the changed conditions under which they are used. Some valuable materials, which are now practically excluded, because of the omission to provide load factors, should be included, and altogether a much broader scope for materials to be used is desirable, and, with proper provision for test requirements, would be perfectly safe.

These are but a few of the important points which have been advanced to show the weak points of the present antiquated law, and the urgent need for proper revision. That this revision should be made with the assistance and advice of competent engineering specialists is evident.

"The work of revision of the structural features of the building law should be put into the hands of a small committee of experts in structural matters whose broad experience in engineering and architecture, and whose character as reasonable men, would insure a comprehensive, safe, and thorough treatment of every feature of the whole matter, so that a building law truly worthy of the greater New York would be secured."

The Gas Engine and its Mission.

UNDER the above title Professor Sidney A. Reeve has written a series of papers for the *Railroad Gazette* which contains much that is valuable and important, and while we can hardly endorse all of the points made, yet we feel sure that the ultimate success of the internal combustion motor as a commercially valuable source of power will depend very largely upon the way in which Professor Reeve's criticisms are met in actual construction.

After reviewing the existing forms of construction and showing that by far the great majority of gas engines in actual service are of the Beau de Rochas, or "Otto" cycle, governed by missed impulses and igniting by electric spark or by hot tube, the writer goes on to show that at the present time the gas engine must still be regarded as a motor for small powers. The average output of gas engines in the United States during the past five years has been about 20,000 h. p., the average size of engine running between 5 and 15 h. p. During the last year or two, however, this average size has increased very perceptibly and is still rising rapidly. Nearly all builders are now offering engines of 30 to 40 h. p. A few more have attained a size of 100 h. p., while two houses offer engines as large as 250 h. p., as nearly ready for the market, although they have none actually running.

The high economy of the gas engine when operated with fuel gas, and the placing upon the market of satisfactory gas producers, renders such motors far more efficient than the steam engine; and yet the replacement of the steam engine by the gas motor does not take place with that readiness which might have been expected from such a gain in economy. Several reasons may be advanced for the slowness of the introduction of the gas engine for purposes of general motive power in addition to the comparatively recent production of motors as large as 100 h. p., and the slow improvement in the gas producer.

"The real explanation lies in the fact that the gas engine, as a machine, cannot be paralleled with the steam engine. It is in no disparagement of the splendid work done in the development of the engine, nor in anything but faith in the future of the engine, that this fact is pointed out as the most significant one in the whole gas power question.

To be specific, attention should be centred upon the nature of the motor cycle. First there is no storage of power anywhere except in the moving fly-wheels; secondly, the source of power is not only an explosion—abrupt and excessive in its vigor—but is an explosion which rigidly refuses to be efficient under any except narrowly specified conditions. Finally, it is an explosion which has to be carefully prepared for beforehand."

The question of starting large motors is one which has been solved in various ways, none of them perfect, but some of them fairly practical, and other methods of promise remain untried.

"The remainder of the difficulties still stand untouched. There is no margin of power. To explain, when a steam engine is overloaded it slows down and pulls hard. It not only has a respectable margin above the load of maximum efficiency before it begins to slow down, but it has a further wide margin of useful activity beyond that point before it comes to a full stop, and during which its speed is a ready indicator of how far it is from stopping. With the gas engine, however, the load of maximum efficiency is that of maximum capacity, but when a gas engine is so overloaded that it once begins to slow down there is no 'grunt and pull hard' to it. It stops; the entire load must be thrown off and a fresh start made."

The crudity of the method of regulation by means of missed impulses, and the great reduction of efficiency when the method of modified gas mixture is used, both show the necessity of devising some improved way of governing, while the problem of reversibility seems to have been accepted by designers as insoluble.

These objections must be carefully grasped and appreciated before the gas engine situation can be understood.

When it is considered that the power plants in operation using power gas in motors form a very small portion of the existing gas engine installations in use, we are forced, as Professor Reeve points out, to the following conclusions: "That the gas engine has spread in use not because it is efficient, not because it is mechanically attractive, but, because its source of power-gas-is a fluid cheaply and conveniently transportable from a central source to a myriad of distant and isolated points of consumption; and that further, the first two arguments—expense and mechanical crudity—have been powerful obstacles in confining the expansive power of the latter argument—transportability—within exceedingly narrow limits."

The superiority of gas over steam for storage, transmission and subdivision, and its marked inferiority as to the motor itself—coupled with its very low cost when used on a large scale lead to the following important conclusions, which may be stated as follows:

"First, the ultimate destiny of the gas engine is inestimably wider than that of the steam engine even, and not to be compared with its present limits; and second, the gas engine which is to fulfil this mission must as a machine, not be content with an inferior approach to the lowest steam engine standards, but must take a high stand as its peer, or even its superior, in mechanical adaptability, delicacy and docility."

The line along which these improvements may be expected is in part indicated by a study of the narrow path traversed by past advance, and the high efficiency of the new Diesel motor is pointed out as due entirely to the extension of the operations to an unprecedented range of pressures. The prediction is made that his fuel rate per horse power hour is no better, and even not so good, as that which may confidently be expected from either the Cayley-Buckett, the Siemens, the Brayton, the Gardie, or any other such general type of engines, when once the designer may appear who is willing to undertake the commercial handling of machines adapted for such working pressures as 45 atmospheres, or 647 pounds per square inch.

The Strength of Sewer Pipe.

SOME experiments recently made by Mr. Frank A. Barbour, of the Boston Society of Civil Engineers, and published in the *Journal of the Association of Engineering Societies*, enable us to acquire some idea of the strength of sewer pipe and the pressures to which it is subjected in the ordinary course of usage.

The experiments were made so as to conform as closely as possible to actual practice, the pipe being laid in a trench in the usual manner, after which pressure was applied by a hydraulic machine to a platform—resting on a filling over the pipe. In the tests of earth pressure the same machine was placed in the bottom of a deep trench, and the earth filled upon a platform resting on the plunger, which communicated the pressure to a gauge.

The tests were made upon sizes ranging from 6 to 24 inches in diameter, and with both the standard and double-strength pipe,—of soft, medium and hard burned grades, as indicated by the manufacturers.

Mr. Barbour has sought to express the relation of the dimensions of pipe to its breaking strength by a formula which follows with reasonable closeness the curves deduced from his tests; but for all practical purposes it suffices to know that the breaking load per lineal foot averaged about 2,800 pounds for the standard pipe and 4,200 of that of double strength.

The trench experiments were made with filling of various materials, loam, sand, gravel, and clay being used, and the pressure transmitted to the bottom of the trench varied from 30 to 60 per cent. of the weight, according to the filling.

In general, the actual pressure at different depths was ascertained, and expressed as a percentage of the weight of earth superimposed. This value, in the case of loam and gravel, was found to be equal to the difference between unity and the coefficient of friction of these materials, and, if this relation extends to other materials, a means is afforded of estimating the actual earth pressures in trenches of all materials of which the coefficients of friction, or angles of repose, are known.

THE BRITISH PRESS

The British Coal Supply.

In his annual address before the British Statistical Society, printed in the *Colliery Guardian*, the Right Hon. Leonard H. Courtney gave an interesting comparison between the rate of production of the British coal-supply predicted by Jevons more than thirty years ago, and the actual figures for the corresponding years; and, in connection with this, he discussed the general subject of coal production in Great Britain and other countries.

As long ago as 1861 Jevons, in his book entitled "The Coal Question," indicated that the rate of production of coal in Great Britain was a subject for serious consideration, and from the results of previous years concluded that, if the output of coal continued to increase at the rate then existing, the actual consumption would within a comparatively brief time overreach the means of supply; he therefore declared that the rate of increase which had been noted could not be upheld.

"As regards the fact of an abatement of the rate of production, the figures of experience abundantly justify the anticipations of Jevons. The rate of increase at the time he wrote was 3 1-2 per cent. per annum, and there was statistical proof that this rate had been maintained for some years before that time; there was further evidence leading to the presumption that something like the same rate had been the law of increase since the beginning of the century."

By taking the rate of 3 1-2 per cent. increase and comparing the computed output with the actual quantities it is found that, as a matter of fact, the rate of 3 1-2 per cent. has not been maintained. Making allowance for some disturbing elements, such as labor troubles previous to 1871, the rate of increase has continuously declined, until in the year 1896 the amount raised was almost exactly 30 per cent. below what it would have been had progress been unchecked.

Jevons also predicted an increase in price, which has only partially been fulfilled, for the very good reason that prices have to a certain extent been governed by foreign competition.

A large portion of this competition has come from the United States. "The figures show that, whilst in 1861 the total coal produce of the United States was less than one-fifth of the amount raised in the United Kingdom, the total quantities raised in the two countries had in 1895 approached nearly to an equality, and this result is of course due to the fact that year by year the rate of increase in the States was greater than the rate in the United Kingdom, and that on the other side of the Atlantic this annual rate, though subject to some variations, was, on the whole, maintained at the same level, whilst in the United Kingdom it has been almost continuously decreasing."

The suggestion has often been made that, long before the diminishing coal-supply becomes a matter of really serious moment, coal will itself have been superseded by other natural sources of energy; and this phase of the question was not overlooked by Jevons, although since his time the utilisation of distant hydraulic power and its transmission by electricity has become an accomplished fact in many localities in which he could hardly have thought it possible. There is no doubt that the harnessing of tide, wave, and wind power, to say nothing of the internal heat of the earth and the radiant energy of the sun, will ultimately do away with all necessity for the mining of coal; but this is a result which concerns the prosperity of Great Britain almost as deeply as the loss of her supremacy in the control of the energy obtainable from coal.

Speaking of such suggestions, Jevons said: "Such a discovery would simply destroy our peculiar industrial supremacy. Electricity has already been zealously cultivated on the continent with this in view;

England, it is said, is to lose her supremacy as a manufacturing country, inasmuch as her vast store of coals will no longer avail her as an economical source of motive power. And, while foreigners clearly see that the peculiar material energy of England depends on coal, we must not dwell in such a fools' paradise as to imagine we can do without coal what we do with it."

It is not the function of the statistician to point out the remedy or to serve as an alarmist, but, as a guide to future conduct, the lessons of carefully-prepared statistics are always of value. Mr. Courtney has shown that the predictions of Jevons have in great measure been fulfilled in the course of time, and, in concluding, he says: "The true way of meeting the difficulties of the future must be through spreading among the people an understanding of its probable course. In an intelligent appreciation of our situation lies the best promise of a perception of personal national duty."

The Water Ballasting of Steamers.

In estimating the amount and disposition of the water ballast for a steamship, the variations in the weight of coal to be carried must be taken into account. The changes which have been wrought by the introduction of improvements in the steam machinery have modified these variations very materially, and the change in the relation of total weight to displacement, caused by the substitution of steel for iron, has also to be considered. These and similar points are discussed in a valuable paper presented before the North-East Coast Institution of Engineers and Shipbuilders by Mr. Archibald McGlashan, of which we give an abstract.

The general tendency of the developments in modern shipbuilding have been: 1, to reduce the cost of ships per ton of deadweight capacity; 2, to reduce the draught of water on which ships may carry a given deadweight; 3, to reduce the consumption of fuel required to carry a given deadweight at a given speed. These improvements are all very desirable from the shipowner's standpoint, but they also bring about an important reduction in the light draught of a vessel under steam, which requires a correspondingly increased ballast, or other weight, to be put on board, so as to give sufficient immersion to enable passages to be made in ballast satisfactorily.

The main purpose of ballast in steamers is to increase their draught of water, so as to make them manageable in rough seas, and to immerse the propeller sufficiently to enable it to do its work in a reasonably efficient manner. In the case of deep and narrow steamers the most suitable place in which to carry ballast is the bottom. But steamers, as now built, have plenty of beam to insure stability, and it is not advantageous in them to carry in the bottom all the additional ballast which they require. Doing so would increase the metacentric height, which in such vessels is already considerable, and make them less sea-kindly in ballast.

It is found in practice that, under present conditions, it is advantageous not only to carry more ballast than formerly in ordinary cargo steamers, but also to carry it at a considerable height above the bottom. In addition to the usual double-bottom tanks, after-peak tanks are used, and are very efficient for trimming a vessel by the stern. Deep tanks are sometimes found in the holds, but are not in favor, as they present many inconveniences in practice.

Side tanks possess many advantages. They consist practically of the double-bottom construction carried up the sides of the ship, thus enabling the increased ballast capacity to be provided as necessary, and to be carried at such a height as to make the vessel easy in a sea way. Such tanks may also prove a source of safety,—as double bottoms have already been,—for injuries to the outer shell would probably fail to penetrate the inner tank plating, which would thus prevent water from reaching the cargo, and in some cases, might prevent the ship from sinking. Side tanks also interfere less than any other form with the stowage of the cargo, and render the hold space more valuable than when it is cut up by internal divisions.

As examples of various degrees of ballasting, a table of a number of vessels is given; one of the most satisfactory steamers in the list had a displacement in the ballast condition of 0.521 of the load displacement, and a draught of water, in the same condition, of 0.589 of the load draught. These proportions are not given as an unfailing guide in determining ballast conditions for steamers, as other elements have a modifying effect; but under general conditions this vessel proved an admirable ship in ballast, and very satisfactory in service.

The importance of taking the modified conditions of ship construction and coal-consumption into account will be appreciated by all who have to deal with the question of ballasting vessels, and Mr. McGlashan's paper is a timely contribution to the subject.

The Development of Electro-chemistry.

THE inaugural address of Mr. J. W. Swan as president of the Institution of Electrical Engineers contains some interesting reminiscences of the past, particularly in connection with the development of the incandescent electric lamp, toward which his own inventions have so materially contributed. The bulk of the address, however, is devoted to the outlook in connection with electrical progress, and in that respect he is clearly of opinion that "those who are aspiring to make their mark as electrical engineers would choose wisely in making a very special study of that portion of the field within which lies the application of electrity to chemical manufactures."

Of this wide field only a small corner has been cultivated, but that is already yielding rich harvests. The electrolytic refining of copper, the extraction of aluminium, the recovery of gold, and the electrolytic production of chlorine and of soda,—all these are assured commercial successes, while a number of minor industries are partially dependent upon the chemical action of the electric current.

In reviewing the historical side of the subject, Mr. Swan called attention to the fact that chemical action was the earliest form in which the electric current, properly so-called, was manifested, and, from the time of Volta down through the fundamental work of Davy and of Faraday, the chemical production and utilisation of the current formed the principal subject of investigation.

From Faraday's time down to the present, the generation of current from mechanical energy has changed the trend of thought and work, and, while electroplating and minor electro-chemical work have been actively conducted, the main progress has been on other lines.

The production of a continuous-current generator by Gramme was the starting point of modern applied electricity. "The two succeeding decades saw the evolution of the modern dynamo; and at the end of this period the critical point was reached, when there was demonstrated, with sufficient clearness to captivate the commercial mind, the fact that, for lighting, for transmission of power, and for effecting several important chemical operations, electricity, as produced through the dynamo by the steam engine or by water power, was a thing of utility, and could be turned in all these ways to commercial advantage.

"These great uses of electricity have been for several years established on the secure basis of commercial success. This result has been reached through the co-operation of many minds, and especially by the union of the skill of the mechanical engineer with the specialised knowledge of the electrician and the chemist.

"Out of this combination and concurrence of forces electrical engineering has grown, and by making new demands has reacted beneficially on purely mechanical engineering. The requirements of electric lighting have largely contributed to those great improvements and economies in electric power-producing machinery, and in the steam engine itself, which have materially assisted in bringing about the degree of success which has now been reached in electro-chemical industries."

Copper-refining by electricity is the practical descendant of electro-plating, and follows from the early-ascertained fact that, no matter how impure the anode may be, only pure metallic copper is deposited upon the cathode plate. The development of this branch of electro-chemistry has been so great that now one-third of all the refined copper produced in the world is made by the electrolytic method. Not only is the process commercially economical, but whatever gold and silver may be in the unrefined copper are saved, while the resulting product is almost chemically pure, and hence of a much higher degree of electrical conductivity.

The reduction of metallic copper from the matte, while not yet fully developed, is an important subject for investigation, and already the Canadian Copper Company is successfully reducing copper-nickel mattes electrically, although as much as 14 per cent. of sulphur is present.

In the important field of gold extraction the Siemens & Halske process enables the cyanide process to be extended to solutions otherwise too weak to pay for working. The electric current will cause the gold to be deposited upon lead plates from an extremely dilute cyanide solution, and now more than 1,000,000 tons of tailings formerly discarded as worthless are profitably treated by this process every year.

The extraction of aluminium by electricity is one of the results of electro-chemistry which suggests what may be expected when the art is further developed, and applied to other substances now as difficult of extraction as aluminium once was; the Castner sodium process is another development in a similar direction.

The most important of all the forms of applied electro-chemistry, however, is the electrolytic production of the alkalies. Hardly has the Solvay process superseded the older method of Le Blanc when the application of the electric current to the production of alkali and chlorine by the decomposition of alkaline chlorides appears, promising to develop into an industry which shall overshadow both its predecessors.

These and many others are but examples of what may be done in the application of electro-chemistry in the industrial arts, and, as Mr. Swan says, it is but the fringe of the matter which has been touched. Already a large amount of valuable work has been done, but there is a limitless prospect of expansion.

The main question for the mechanical engineer in all this lies in the economical generation and application of power. At the present time water power is generally looked upon as the most economical source, but it is possible that, when all costs are included, steam power may be a close rival. The conditions under which steam power is used in electro-chemical manufacture are extremely favorable to economy, where coal is cheap, the unit of power large, and the use of power continuous and uniform.

"In the time that has passed, Britain has enjoyed in chemical manufactures a great advantage in the possession of an abundance of coal. We are about, in some measure, to lose the benefit of this advantage through the innovations of electro-chemistry. Whether we profit or lose by the change largely depends on our readiness or unreadiness to adapt ourselves to the new order of things."

Hydraulic Motors.

In adapting water under pressure to the generation of power, one of the practical difficulties has been the excessive waste when running under light loads. No matter what the load may be, the cylinders must run full of water, and, the governing being effected merely by throttling the supply, there is no opportunity for economy.

This feature of piston hydraulic motors is discussed by the well-known engineer, Mr. Arthur Rigg, in a recent number of *The Engineer*, in connection with an account of an improved device of his own invention, intended to remedy the difficulty.

Since there is only a liquid under a positive pressure to be considered, there is no expansive force to be dealt with, hence the most obvious way of altering the power of a motor is that of varying the stroke,—an ideaapplied as long ago as 1858 by Messrs. Knowlden and Edwards, who made a three-cylinder engine in which the radius of the crank could be changed by the action of two hydraulic rams. Pressure was conveyed through the centre of the shaft, and it was intended that the stroke should be changed while the motor was running; but the device does not seem to have been a success, probably from constructive reasons. Several other attempts have been made, the best known being that of Mr. Hastie, of Greenock, in which the radius of the crank was varied by a cam acting against a spring resistance in such a manner as to form a dynamometric governor, the stroke being lengthened as the resistance increased, thus giving greater leverage to the pressure upon the pistons.

The difficulty of adjusting the stroke while the engine is in motion, Mr. Rigg gets over in a very simple and ingenious manner. He uses an inversion of the ordinary type of motor, and causes the crank to stand still while the cylinders revolve around it, thus making it possible to so connect the crank to a governing mechanism as to enable the pressure water to be used in proportion to the work done, while a close approximation to a uniform number of revolutions is maintained.

The mechanical details by which this system is executed may be varied, but the principle remains the same. In the motor shown, which is used for driving a grain elevator, the crank pin is shifted to or from the centre by means of auxiliary hydraulic cylinders controlled by a centrifugal governor, and the power developed varies between 20 and 4 h. p.—a saving, in comparison with engines of fixed stroke, that sometimes amounts to 80 per cent, for light loads.

The Utilisation of Blast-Furnace Gases.

REFERENCE has already been made in these columns to the successful use of blast-furnace gases in gas engines in Belgium, and this problem has also been successfully attacked in England.

In an article in the *Electrical Review* (London), dealing principally with the subject of the generation of electricity by gas power, this question of blast-furnace gases is also mentioned, especially with reference to the tests of Mr. W. H. Booth on the Thwaite blast-furnace power system.

"Basing his figures on an assumed production of 200,000 feet of gas per ton of fuel, the consumption of gas per electrical horse power was found to be 133 feet per hour. The 200,000 cubic feet were obtained from the gas analysis. With slightly different furnace *régime* and the works manager's figure of only 180,000 feet per ton, Mr. Booth gives the consumption per e. h. p. as only 105½ cubic feet. These figures entirely neglected the amount of heat that disappeared in the pig bed and in the slag, etc., showing how very efficient as a gas-producer the blast furnace proves to be, and indicating not only the high economy to be secured from the method of utilising the waste heat of the blast furnace, but pointing to a time when the manufacture of producer gas will be carried on upon a large scale, the working of producers being best when of large size. Indeed, the blast furnace, though designed to produce pig iron, is an ideal gas-producer, and, while we envy America her Niagara, we have in England, within easy reach of every large town, large power-producers from which at present very little is being done. Look at the matter from whatever way we will, it appears that gas power in the near future will more and more encroach upon the field hitherto filled by the steam engine. We do not think that the use of illuminating gas, to give the mixture its courtesy title, will ever prove commercially economical for stations of any serious power. To be a success, gas of the producer type must obviously be employed, and it is most important that the producer plant be constructed in a thoroughly mechanical manner. We have seen promising power stations ruined from want of attention to this point. There is no occasion for dirt, dust, and smoky fumes in a gas-producer house."

That the gas engine is destined to crowd the steam engine very hard as a generator of power from heat we have long believed and frequently emphasised, and the present revival of interest in both engines and producers indicates that the general introduction of internal combustion motors in large units is the next great change which we shall see in the industrial application of power.

By uniting the smelting of iron with the production of power gas two of the greatest industrial operations in the realm of applied science will be combined, and in England especially, where the question of competition with the cheap hydraulic power of Switzerland, Germany, and even Norway is impending, this utilisation of the power now wasted in the discharge gases of blast furnaces may prove of the utmost importance.

The Protection of Iron from Rust.

THE use of paint as a protection from rust is so general that to attack its efficacy seems almost a heresy, and yet it is well known that the protection it affords is only partial, and that, in spite of many and frequent coats of paint, iron work will rust. A leading article in *The Engineer*, in discussing this subject, shows that there are many good reasons why paint should not be an efficient protecting material The pigment contained in a paint possesses no protective value in itself, dependence being really placed upon the liquid matter alone; hence, in using heavy coloring matter, assuming that the proportion of oil per square foot remains constant, the engineer is simply paying more money for a substance not only of no service, but positively deleterious to the rest of the material.

Linseed oil, however cannot be used alone, since it expands on drying, and the resulting film is apt to be rugose; moreover, if the adhesion of the oil to the metallic service is not perfect, it may cause the production of blisters. The lack of stability possessed by the solid body resulting from the oxidation of the oil also causes it to crack and fall to pieces; hence as a protection against rust it is not successful.

Varnishes have been suggested, but many of them are apt to crack and peel, or else are so porous as to permit moisture to penetrate. A few varnishes are free from these defects, but their cost renders their use for this purpose impracticable.

Better results in many ways are obtained by the use of such materials as tar, pitch, or asphaltum, and, although they may not altogether respond to the demands of the ideal specification, they will be found to possess many serviceable qualities. Coal tar has been charged with possessing a corrosive action upon iron, although this action is said to be prevented by heating with lime; but pitch, softened with creosote and dissolved in one of the cheaper light oils recovered during distillation, or in a corresponding petroleum derivative forms an excellent protective varnish.

Asphaltum dissolved in a spirit solvent is also suggested as a safe and suitable paint for the protection of iron work, and this may also be used in connection with linseed oil for a second coat. This, indeed, seems to form the ideal combination. The iron should first be cleaned from all scale or rust, and every trace of moisture removed, after which a thick priming coat of pure boiled linseed oil is applied, and carefully worked into all cracks and crevices. When this has become perfectly dry and hard a second coat of black varnish, composed chiefly of pitch or asphaltum should be applied, the combination forming the best protection against rust at present available.

Probably in this connection the use of the sand blast for obtaining a thoroughly clean surface would greatly assist the protecting medium by enabling it to make a perfect contact with the surface of the metal.

The Electrical Driving of Machinery.

IN his presidential address before the Northern Society of Electrical Engineers at Manchester, Mr. John Raworth utters a number of timely and vigorous remarks about the advances in the application of electricity which ought to be made without delay, and one of the most important of these he declares to be the driving of machinery for manufacturing purposes by electrical distribution of power, including the total abolition of line shafts, countershafts, wheels, ropes, pulleys and belts.

"The day for tinkering with this problem is now over; every man knows that it can be carried through with absolute certainty, with satisfaction to the manufacturer, and with enormous saving both to himself and the community. But the manufacturer does not yet know that the shaft of his machine can be fitted with a three-phase motor without commutator or brushes, and less complicated than his present double pulley and strap fork. When you have succeeded in impressing him with this fact, the remaindar of your task will be an easy matter, but it must be undertaken methodically. The first step is to appoint a commission to settle uniform periodicity and voltage; the second is to equip an electrical manufactory capable of turning out 500 cheap motors per week; the third is for machine makers to attach the motor in place of their present pulleys, so that when a manufacturer buys a machine, he buys it all ready for attachment to his power circuit.

Having reached this point, it is obvious that the manufacturer will no longer desire to buy coal; he will be quite satisfied with watts, which may be produced at the pit's mouth and sold retail for less than they can now be supplied mechanically to the machine axis.

The whole question of external supply of power turns on this question of economics. Your manufacturer will not care two straws for your electrical development or for the annihilation of the smoke cloud which he interposes between the sun, the source of all our joys, and the dismal streets of Manchester; but his eyes will gleam with rapture if you can prove that you can save him a thousand a year.

Happily your task is an easy one so far as argument is concerned; and if illustration be required I am not sure that we members of this society could spend our savings to better advantage than by taking a representative deputation of Lancashire and Yorkshire manufacturers through Switzerland and Germany to show them how the old order is giving place to the new; how the millwright is disappearing in favour of the electrician; how 25,000 mechanics are struggling to keep pace with the demand for electrical machinery, of which about three-fourths is required for electrical purposes.

In America the same process is going on, so it follows as a matter of course that we must either quicken our pace or drop out of the running altogether.

Happily the coal pits around Manchester are so close to the city that there will be no new difficulties in transmission, and a very moderate voltage will suffice. It is obviously outside our province to discuss the various possible methods of raising the capital. My own impression is, that when the profitable nature of the investment comes to be understood, there will be no difficulty in raising a million to put down a pioneer plant of 50,000 horse power with an earning capacity of close on £200,000 per annum."

All this is very true, except that Switzerland and Germany and many portions of America have water power available, while this in England is mainly lacking, and this Mr. Raworth perceives, for he proceeds to show how with the introduction of electrical driving more economical and efficient steam engines must be developed.

"Although we make good steam engines, in spite of of American comments to the contrary, we have not made economy our first consideration; we have, moreover, been confirmed in this practice by the belief that economy of coal could only be obtained by increased capital expenditure and troublesome complications. But that view is totally and fundamentally erroneous."

For large units and for fairly uniform loading a high economy can be obtained with engines by no means either complicated or of high first cost. In this connection Mr. Raworth referred to multiple expansion engines and especially to the Schmidt superheated steam motor, more fully described elsewhere in this issue, and urged upon English engineers to exert themselves to fill the coming demand both for electrical and power plant and not permit it to be captured by foreign competitors.

Engineering in 1897.

An excellent review of the progress which has been made during 1897, in the various branches of "the art of directing the great sources of power in nature for the use and convenience of man" is found in a late issue of *The Engineer*, and some of the salient features there brought out, are well worth considering, especially for the bearing which they have on the engineering work of the present year. Although this review naturally deals principally with British engineering, it includes also important work in other parts of the world and thus gives from a British standpoint a picture of the doings of the engineer in the past year at which we may well take a thoughtful look.

In civil engineering, naturally the greatest works have been those involving the development of new countries, or rather the re-development of very old countries. England's position in this respect is summed up in a few words, which are full of meaning: "All we have to do is to keep ourselves thoroughly well abreast with the times, and with the men of other European nations, bearing in mind that a certain and a very fair portion of the work must be reserved for us by virtue of its position on British territory."

Russia has been, and still is pushing forward the work on the Siberian Railway, and incidentally is reported to be exerting pressure upon China to exclude English engineers on internal works. In India nearly four thousand miles of railway are under construction, while in Africa the completion of the Buluwayo extension is only a fraction of the exploitation of the southern portion of the dark continent by the engineer.

The replacement of the Victoria tubular bridge at Montreal by a modern cantilever is an excellent example of the progress in long span bridge construction which has been made in the past fifty years; while in India and Australia a number of important bridges have been built, and others are contemplated.

In mechanical engineering the two branches of locomotive construction and marine engine building have occupied the greatest share of attention although but little that is really new can be recorded. Compound locomotives on land, and water-tube boilers at sea, have evidently both come to stay; while the steam turbine has maintained itself as an object of interest with a future before it which the coming year may convert into something more than a promise.

The work of the military engineer has been along the old lines of "gun against armour," with the latest advantage on the side of the projectiles, but with the armour a close second. Quick-firing guns have been, and are still being improved, and it is a question whether in naval warfare at least, this portion of the armament may not develope into a position of controlling importance.

Sanitary engineering has made slow but constant progress, and the two great branches of pure water supply, and purified sewage discharge have at least gained in status, if not in execution. The whole broad subject of municipal engineering, including water supply, paving, lighting and drainage has during the past year made distinct progress, but its future is yet before it and not "behind it," as has been humourously remarked of certain other subjects.

Electro-chemistry is the branch of electrical science which has made the greatest advances of late, probably because it was the branch in which the least previous work had been done, and even now the best work and closest study is being given in Germany and in France rather than in England.

Altogether the engineer has done good work in 1897. Travel by land and by sea has been rendered swifter, safer, and less wearisome. More power has been obtained from burned coal than ever before, and other ways of obtaining power than by burning fuel have been developed. Harbours have been improved, waterways extended, rivers spanned, and railways built. It will not be long before a similar record will have to be made for 1898, and the present outlook indicates that progress will be along the same lines and at an accelerated rate.

THE CONTINENTAL PRESS

Superheated Steam.

In nearly all of the recent researches into the question of the internal wastes of the steam engine the question of cylinder condensation has shown itself a most elusive problem. Jacketing has proved a palliative only in certain cases, compression has been shown to cause nearly as much loss in one direction as saving in another, while reheating, in the case of multiple-expansion engines, has not given as yet the economy hoped for. Superheating was one of the earliest methods proposed to reduce cylinder condensation, and it has been mainly due to constructive and operative difficulties that it has not received as wide an application as its merits warrant. While it has never been as generally abandoned on the continent as in the United States or England, it is only recently that systematic efforts have been made to improve superheaters and to design special engines for the use of superheated steam as a medium for the transformation of heat into mechanical energy. In Alsace and in England the question of superheating has been taken up anew; in the United States Professor Thurston, and in Germany Professor Schröter, have directed attention to the subject; and in France, Belgium, and Italy it is again being discussed.

A valuable series of articles upon the application of superheated steam in engine practice, written by Professor Sinigaglia, of the engineering school at Naples, has appeared in recent issues of the *Revue de Mécanique*, treating the subject from both a historical and practical point of view; while, in the *Zeitschr. des Vereines deutscher Ingenieure*, Professor Seeman, of Cannstadt, discusses engines for use with superheated steam, and especially the Schmidt engine, which, during the past year, has given some very excellent results.

Professor Sinigaglia refers to the remark of M. Bertrand that what we call saturated steam really does not exist in practice, since a very slight change of pressure or temperature is sufficient to make the difference between a superheated steam and a mixture of steam and water. In a working engine, therefore, the fluid in the cylinder is always in a state of instability and subject to very complex conditions, and it should be our effort to render these conditions as favorable as possible for the utilization of the energy of the heat.

Much attention has been given to steam economy in Alsace; indeed, Professor Unwin not long ago said that in the use of steam the Alsatian engineers had accomplished better results than any others. M. Walther-Meunier, the chief engineer of the Alsatian Association of Steam Users, has made a great number of tests upon engines using both saturated and superheated steam, and in his extracts from these reports Prof. Sinigaglia gives valuable comparisons between various methods of working, and shows just what degree of economy may be expected.

Among these tests may be noted those of MM. Ludwig and Weber upon the steam plant of MM. Kulmann & Co., at Wittenheim. In this case a triple-expansion engine of the Frikart type was supplied with steam by a battery of elephant boilers, and an independently-fired superheater of the Uhler style was applied. The trials were made with conditions as nearly uniform as possible, excepting that the superheater was used in the second series, so that the difference, if any, should be clearly accounted for. In the article referred to, the results are fully tabulated, and, in brief, the steam-consumption in a 700-h. p. triple-expansion engine operating at 160 pounds' pressure with saturated steam was 13.2 pounds per h. p. h., while with 75° F. superheating this was reduced to 11.7 pounds,—a saving of 2.5 pounds, or 19 per cent. Another test upon the engines of the spinning mills at Mulhouse, on an 800-h. p. triple-expansion Corliss engine, operating with steam of 164 pounds pressure, showed a consumption of 14.2 pounds of steam per h. p. h., without superheating, while with 75° F. superheating the consumption fell to 11.3 pounds.

In these cases, however, the superheated steam was used in engines originally intended for saturated steam, or at least for the moderately-superheated steam obtained in well-designed boilers without special superheating apparatus.

In the article of Professor Seeman to which reference has been made the question of using a much higher degree of superheating, in engines especially adapted for such conditions, was discussed, and tests of the Schmidt superheated steam engine were given in detail.

The Schmidt engine possesses several peculiar features, which may be briefly noticed. It is a single-acting compound engine with both cylinders in the same axis and with a differential plunger piston, the high-pressure cylinder being formed in the head of the low-pressure cylinder. The crank end of the large cylinder constitutes a receiver of varying capacity, while the annular space around the plunger in the head end of the large cylinder forms the low-pressure cylinder.

The steam first enters the high-pressure cylinder, from which it passes to the receiver space in front of the large piston; on the next out-stroke it flows from the receiver to the annular low-pressure space, whence it exhausts to the condenser, while the compression takes place in the receiver. The distribution is effected by poppet valves, operated by eccentrics upon a side shaft geared to the main crank shaft.

The first engine of this sort, of 60 h. p., was tested early in 1895 by Professor Schröter, with steam at 160 pounds' presssure and 280° F. of superheat, and gave the remarkable steam economy of only 10.46 pounds (4.55 kilograms) of steam per h. p. h. while a similar engine of 120 h. p., tested by Prof. Seeman in November, 1896, with a steam pressure of 164 pounds and a superheat of 290° F. gave an i. h. p. with only 9.8 pounds 4.44 kilograms) of steam per hour!

Hydraulic Mortar.

CEMENT and mortar tests have been so extensively made and discussed that the subject may seem almost exhausted, but the value of such tests depends so much upon the manner in which they are conducted and investigated that a study as scientific as that made by M. Feret, the head of the laboratory of the *Ponts et Chaussées* at Boulogne, and published in the *Bulletin de la Société d'Encouragement*, demands recognition.

M. Feret first describes and tabulates the extensive series of tests for resistance to tension, compression, piercing, and shearing which were made in the laboratory under his charge, the same Portland cement being used in all cases, in connection with various kinds of natural and artificial sands, the intention being to investigate rather the physical properties of various mixtures than the comparative merits of different cements. The results are given in tabular form, and also plotted in curves, showing graphically the general behaviour of the materials, after which the effect of variations in a series of test samples is discussed.

Attention is called to the fact that widely-different results may be obtained from the same material, according to the manner in which the tests are made, and emphasis is strongly laid upon the point that tests are not comparable unless they have been made in the same manner.

In tests for flexure, for instance, the size of the specimen is of great importance, since the distance of the outer and more resistant portion from the neutral axis has a great influence upon the result, and in general the greatest resistance of any specimen is found in that portion nearest the exterior. An unequal distribution of stresses must, therefore, appear in tension tests as well as in those for flexure, and this inequality is still greater when the mixture is not perfectly homogeneous.

According to the theory of resistance of materials, tests by flexure and by tension should lead to the same ultimate strength, but deductions based upon materials of supposedly perfect elasticity do not hold good for mortars, especially as the point of rupture is approached. M. Durand-Claye has shown that the resistance deduced from flexure tests is almost double that obtained from direct tension, and the tests of M. Feret bear out the fact that there is a definite ratio between the two resistances,—namely, the resistance by flexure is to that by tension as 1.89 to 1, or, in round numbers, as 2 to 1.

Similar relations were deduced between the resistance to compression and to shearing and punching, a constant and proportional ratio being found. There does not appear, however, to be any such proportionality existing between the results obtained by tension and by compression tests, and two different mortars having the same resistance under compression may show very different results in tension. As a result of much experience deduced from many tests, M. Feret states that he believes the test by compression gives the real measure of the coherence of a mortar more nearly than does a tension test. In all cases the compression tests gave more uniform and consistent results, both for large and small specimens and for various conditions of homogeneity.

The most important part of M. Feret's paper, however, is that relating to the physical constitution of a hydraulic mortar, especially with regard to the size of ultimate particles of the materials employed, and to the thoroughness of the admixture.

For a very fine sand the resistance to crushing is much greater than for a coarse sand, the proportion of sand to cement being the same in both cases. A tabulated series of tests, using a constant quantity of cement and sand, but with different proportions of fine and coarse sand, showed that the resistance to compression was two and one-half times greater with fine sand than with coarse, and corresponding variations appeared with the other mixtures.

An approximate measure of the nature of a mortar in this respect may be obtained by determining the density, or, as M. Feret calls it, the "compactness," of the mixture, since this bears a relation to the proportion of voids between the particles, which doubtless plays an important part in the strength of the mortar. In plotting the results of the tests made with sands of various degrees of fineness, M. Feret uses the ingenious form of triangular pyramid adopted by Professor Thurston in his investigation of the strength of various bronzes, and in this manner the results are shown with a clearness not otherwise possible. Similar diagrams are given for mixtures of sand, cement, and pulverized slag, and the paper closes with data as to the effect of the addition of a proportion of puzzolana to cement and sand, especially for hydraulic mortars which are to be exposed to the action of sea-water.

Current Motors.

In utilizing the energy of water-courses such streams are generally chosen as have sufficient fall within moderate length to permit the development of a considerable head, or preferably such natural waterfalls are taken as need but little constructive work for adaptation to power generation.

There is, however, in all flowing streams a large amount of energy existing in the force of the current, and from the earliest times current mills in crude forms have been constructed to enable some portion of this power to be utilized.

In view of the present desire to obtain cheap motive power, this subject of the utilization of flowing streams is being revived, and in a recent issue of *La Revue Technique* an account is given of the von der Heydt system of current motors, which contains much of interest.

The fundamental principle of the von der Heydt system is the employment of a floating or submerged dam, which contains in itself the motors and electric generators by which the energy of the current is transformed, and which may be swung aside bodily when it is necessary that the water-way should be unobstructed for purposes of navigation.

In the simple instance of a small stream, the dam consists of one pontoon as long as the width of the channel, divided into a number of compartments, each compartment containing a turbine on a horizontal axis geared to a generator in a water-tight chamber above. The pontoon is held in position across the stream by suitable cables in such a manner that it may be swung alongside the bank at short notice, and, by the filling of certain compartments with water or with air, it may be submerged or floated at will.

The flow of the current, due to the natural slope, provides a large part of the power, and this is augmented by the rise due to the obstruction of the water by the dam. Even where the natural current is slow, the large volume of water in many streams represents much power, and M. von der Heydt estimates that on the Rhine between Bingen and Coblentz 1,000 h. p. may readily be taken off without appreciably affecting the general action of the river.

For wide streams the dam may be divided into several sections, and possibly one or more piers may be required in the middle of the channel, in order to facilitate the support and control of the pontoons. When the depth of water is great enough to make it necessary, a sort of flap is provided beneath the pontoon proper, in order to prevent too much of the current from passing beneath, and special arrangements of details may be necessary for special locations. The independent action of a number of turbines thus ranged across a stream permits each to adapt itself to the velocity of the current at its particular point without interfering with any of the others, the only connection being the feeding of the various generators into the same circuit. The use of accumulators provides for any irregularities in flow, and also maintains the current when for any reason the dam is swung aside.

Experiments made on a dam of this construction at Coblentz enable definite data about the system to be obtained. The river at that point is about 1,000 feet wide, and the presence of the dam raised the level of the water about one foot. A flow of more than 20,000 cubic feet per second resulted in the development of about 2,500 h. p. M. von der Heydt makes an allowance of 50 per cent. for losses, including the time the apparatus is out of use, and assumes that 1,200 h. p. may be taken as the output.

From such preliminary data as could be deduced from the cost of this experimental installation, making liberal allowance for interest on the original capital as well as for depreciation of the dam and its contained machinery and including all necessary operating expenses, the cost of an electrical horse-power with this device would be about 140 francs per year.

The idea of using floating pontoon dams for power purposes was suggested, doubtless, by the action of the various pontoon bridges across the Rhine, and for many locations this system may enable much power now wasted to be utilized.

The Dortmund Canal.

THE agitation in Germany for better and cheaper internal transport still continues, but it is found difficult to harmonize the conflicting interests of different localities. Especially in the mining region of Westphalia there exists a continual demand for relief, not only from the cost of rail transport, but also from the congestion which frequently occurs when low water in the Rhine delays river traffic and causes the railways to be crowded beyond their car-capacity.

This phase of the subject was discussed with much energy at a meeting held recently at Essen, of which an account is given in *Glückauf*, and the claims of this important industrial portion of Germany were urged in no uncertain manner.

The general extension of the canal system of Germany as proposed and discussed at the various conferences at Berlin, Vienna, and Hanover, including one or more systems of continuous waterways between the Danube and the North sea, has met with so much opposition from the agricultural portion of Central Germany, because of the feared influx of Hungarian grain, that its final acceptance is most uncertain. Such being the case, the mining industries of Westphalia and the Ruhr districts are urging the construction of only that portion of the work which will suffice to give a water outlet at all times from Dortmund to the Rhine.

As Councillor Behrens plainly said: "The situation is such that no plan for a midland canal can hope to go through. It would fall before the opposition of the farmers of the Elbe, before the opposition of the manufacturers of Silesia, and especially before the opposition of the lignite industry of Saxony."

A canal from Dortmund to the Rhine could excite no apprehension as to an influx of foreign grain, but it may meet a more powerful opposition from the railway monopoly which now controls the transportation in this densely-populated portion of Germany.

The proposition to construct a canal from Dortmund to the Ems, and thus to the North sea, did not meet with the same favor that the proposed Rhine canal met with, as the latter not only would be shorter, but would give access to the great public waterway, and make the entire district free from the exactions and limitations of the present monopoly.

The outcome of the present agitation cannot now be foreseen, but the pressure for better service is so strong that it is probable that, before a great while, the matter will take tangible shape. The miners and iron manufacturers know what they want, and they form altogether too powerful and influential a portion of the community to be easily suppressed.

Explosives in Gaseous Mines.

THERE have recently been several important investigations in different countries concerning the conditions of ignition of explosive gases in mines, the intention being to prevent as far as possible the danger in working mines in which the existence of firedamp is suspected, or even positively known.

A frequent cause of mine explosions lies in the ignition of the firedamp by the action of the mining explosives, such as nitro-glycerine, dynamite, and the like; and, in a paper in the *Oesterr. Zeitschrift für Berg- und Hüttenwesen*, Gen. von Lauer discusses very thoroughly the behavior of various blasting explosives in this especial respect.

A frequent cause of gas ignition lies in the discharge of unburned combustible from the bore hole, or rather of still burning material into the combustible atmosphere of the mine. This is a common defect of ordinary gunpowder, and it is well known that the ground in front of a battery which has been in action is often covered with unburned powder which has been thrown out by the force of the discharges. For mining purposes it is therefore most important that complete and rapid combustion should be insured, and that no unburned or burning material be thrown out.

Another important feature is that of the size of the charge. Explosions are much more apt to occur with heavy charges than with moderate charges. The size of charge used should bear an intelligent relation to the work to be done, and von Lauer discusses what he terms the "coefficient of charge," which is intended to enable the charge for any given case to be little more than necessary to rend the rock, without blowing out an excess of highly-heated gases. Of course any attempt to compute this coefficient must depend largely upon empirical conditions, but tables are given for various kinds of rock as well as for coal, using different well-known explosives, from which a general idea can be obtained.

The direction in which the bore hole is run also has an effect upon the completeness of absorption of the force of the explosion; when the hole is run downward in an inclined direction, there is more probability of an effective rending of the rock, and less likelihood of a discharge from the bore hole, than when the latter is run in at right angles to the surface of the rock.

An important question in connection with the use of explosives in mines is the temperature of explosion as compared with the temperature of detonation of the mine gas. The experiments of the French commission determined the limit of the exploding temperature of firedamp to be 2,200° C. This temperature is exceeded by some of the nitro-glycerine explosives, but with the ammonia-nitrate explosives, and with explosives prepared especially with this end in view, the temperature of explosion may be kept low as 1,200° to 1,900° C.

A large number of actual cases of various kinds are tabulated and discussed, these serving chiefly as material for determining the best proportions of explosive to be used. In conclusion, the following general points are laid down:

"In mines containing explosive gases any blasting explosive which contains no non-combustible or non-gas-forming material may safely be used, when:

1. The charging of the holes is carefully proportioned to the work to be done, so that too violent explosions may not occur;
2. The charges are exploded by central ignition;
3. The primer by which the explosion is effected contains a sufficient quantity of fulminate to insure a complete ignition of the entire charge, preventing the throwing out of any deflagrating material;
4. The tamping with which the bore hole is closed extends from one to one and one-half times the length of the loaded portion, thus rendering a discharge of the explosive out of the hole impossible."

The Renewal of Incandescent Lamps.

MANY attempts have been made to restore the burned-out filaments of incandescent lamps and thus save a large portion of the material now lost, but thus far little success has been attained. In an article in the *Elektrotechnische Zeitschrift* a review of the various methods proposed is given, with some comments upon the causes of failure, which may be of value in further experiments.

One of the earliest methods was that proposed by Hess in 1891, and consisted in opening the sealed tip, filling the bulb with a liquid hydrocarbon, and repairing the filament with the deposited carbon. While this could be done, it was found that a filament thus repaired soon broke at another point, and that the real life of the lamp was prolonged for only a very short time.

Other attempts—notably those of Ponthonier, Möhrle, Chapman, and Carey—involve the attachment of a fresh filament to the original supports, but these have failed, either from cost or from imperfect connection, while the use of stoppers is hardly practicable as a means of securing a permanent air-tight joint.

The latest method proposed is that of Herr Becher, of Vienna, and requires the use of a special form of bulb with a longer neck than is now customary, this neck being also sufficiently wide to permit a looped filament to be passed through it. The terminal wires are of platinum only where they pass through the glass, and have nickel continuations with tubular clips at the ends, to which the ends of the carbon filament are attached.

When a loop needs renewal, the neck is cut, the burned-out filament removed, and a new one inserted into the clips. The new loop is then passed through into the bulb, and the neck fused together, after which the lamp is exhausted and is again ready for service.

It is claimed that this can be done at a cost of only six pfennigs, which is reasonable enough, but it is a question whether so low a cost can be realized, and, unless a much lower figure than the price of a new lamp can be assured, no method of repairing incandescent lamps can hope to be commercially successful.

Stone-Cutting With Wire Saws.

AN account of the St. Triphon stone quarries near Bex, in the Rhone valley, is given in a recent issue of the *Schweizerische Bauzeitung*, which is of interest because of the successful use there of the system of sawing the stone by means of a continuously-running steel wire charged with wet sand.

The wire used for this purpose is of steel, and consists of a three-strand cable, about one-fourth of an inch in diameter, which is carried in the form of an endless rope over a system of pulleys. The pulley at one end of the system is the driver, and that at the other a tightener, while the intermediate pulleys are so arranged as to enable one part of the rope to be pressed against the portion of stone from which the block is to be cut.

The cable is driven at a speed of 1,000 to 1,200 feet per minute, and, as it enters the cut, it is charged with a siliceous sand in a small jet of water. The sand, carried in the twist of the cable, forms the actual cutting material, and performs its work rapidly and well.

The stone quarried at St. Triphon is a hard black limestone of the lias formation, with a crushing strength of about three hundred tons per square foot, and hence offers a very fair test of the capabilities of this substitute for the usual method of sawing stone with reciprocating saws. The rate of cutting varies with the quality of the sand used and with the length of cut, and ranges between three and six inches per hour.

The cables are furnished in reels of 3,000 to 5,000 feet in length, and a running cable contains about 500 feet, the splicing being done at the quarry. Such a cable can make cuts of 100 feet long, if necessary, and will dress about 1,000 square feet of surface, or more than 500 square feet of cut, before it becomes worn too smooth to hold sand.

The general working of this method at the quarry is very simple. In order to remove a ledge of stone, it is necessary to cut pits about a yard in diameter and as deep as the ledge, or, rather, as the desired cut. The frames carrying the guide-pulleys for the cutting portion of the cable are then braced in two of these pits between which the cut is to be run, and the cable is started. At first it runs upon the surface of the rock, but, as the guide pulleys are fed downward, the cut is carried down to the full depth of the pits. Several cuts can be made between the same pits, until finally the ledge is entirely cut into blocks which are held only by their bottom surfaces and can readily be split off by wedges. These large blocks are then removed by a powerful electric traveling crane, and further sawed into any desired sizes, after which the crane again loads them upon the cars for transport. The crane is rated at a capacity of 30 tons (metric), but a block containing 460 cubic feet and weighing 33 tons has been quarried and handled successfully.

Iron Theatre Construction.

FIREPROOF construction is nowhere of greater importance than in auditorium buildings, and often the knowledge that a theatre is not fireproof has much to do with the development of a panic at slight alarm, while the contrary assurance tends greatly to quiet a frightened audience. It was such considerations which led to the rebuilding of the Variety Theatre at Prague, and the account of the conversion of this dangerous wooden structure into a first-class fireproof theatre, as given in the *Wiener Bauindustrie-Zeitung*, is a valuable contribution to this branch of work.

The old building was a wooden hall, 90 feet wide and 105 feet long, with exposed wooden roof trusses of simple construction, and several years ago it was decided to be an unsafe structure in which to permit large crowds of people to assemble. New plans were therefore prepared by the architects, Professor Ohmann and Herr Rudolph Krieghammer, for the conversion of the old hall, not only into a fireproof structure, but also into a modern theatrical auditorium.

In the article referred to the arrangement of the iron construction is very clearly shown, especially the manner in which the oval iron ceiling is suspended from the main roof trusses, and also the cantilever construction of the galleries. There are seven main roof trusses of 93 feet 6 inches span, from which the framework of the ceiling hangs. The central portion of the ceiling, as already stated, forms an oval vault, and this is intersected on the lines of the two axes by cross vaultings, the whole forming a very complicated system of framework, extending to the walls in a series of arches and lunettes. This is to be covered with a layer of concrete three-eighths of an inch thick, and the columns and cantilever beams which support the boxes and galleries are protected in a similar manner. A circular opening is provided in the centre of the ceiling directly over the great chandelier, and a sheet-iron ventilating shaft communicates with the outer air for ventilation as well as safety.

The working drawings accompanying the article show very clearly the details of this excellent piece of auditorium construction, and among the various parts may be mentioned the suspension of the proscenium arch from the main roof truss overhead, and also the details of the gallery construction. These and other features are also well shown by photographs of the work in course of construction.

The whole forms an excellent example of engineering work as applied to a special form of building construction, and, as such, is worthy of study and record.

Business Methods in Russia.

In discussing the subject of trade with Russia, especially in the branch of machinery and engineering supplies, M. P. Jannetaz brought before the *Société des Ingénieurs Civils de France*, a short time ago, the importance of complying with Russian business customs in order to obtain success.

As a matter of fact, Russia purchases almost all the machinery that she uses, the annual expenditure for tools and supplies of all sorts amounting to nearly 160,000,000 francs per year. As the portion of France in this large trade is only about 2,000,000 francs, M. Jannetaz thinks it worth while to examine the causes which permit other countries to obtain a disproportionate share, and his account of the business methods in Russian machinery trade are interesting.

M. Jannetaz refers especially to an important and interesting work by M. Verstracte, the French consul, which bears the title of "*La Russie Industrielle*," and includes mining and metallurgy, machinery, civil engineering, textile industries, manufactured products, and industrial art, as well as primary and technical instruction.

According to M. Verstracte, the Russian customer is a ready purchaser of articles which he can examine and handle, and is an interested visitor at fairs and exhibitions which give opportunity for actual inspection of machines and methods. Catalogues and descriptions have but little weight with him, and the work of the salesman is usually wasted, if the articles themselves are not shown. This fact is well understood by England and Germany hence they have established in the principal cities of the empire local exhibition rooms and offices, where the principal articles of manufacture are on exhibition—not for sale, but as samples. These show-rooms are in charge of competent engineers, usually of Russian nationality, familiar with local methods and ready to assist and advise the customer.

Of late there has been developed a tendency toward specialization, and where formerly all kinds of goods were found in one place, now separate exhibitions are made; some consist entirely of electrical apparatus, others of machine tools, and still others of agricultural machinery.

It is evident that such compliance with the business methods of the country must draw the larger portion of the trade to the nations which have had the good sense to grasp the situation, and it is foolishness for France, or the United States, or any other nation, to expect to capture much business without adopting the same system and giving the same opportunity for the machines to be examined and appreciated. In this instance at least the old maxim certainly holds good: "Well displayed is half sold."

Electric Tramways in Germany.

The *Elektrotechnische Zeitschrift* publishes at the beginning of the year very full statistics of the electric tramways in Germany, brought down to September 1, 1897, showing the rapid growth of electric traction in that country. At the close of 1891 but three towns had electric traction in use, while in 1897 the number had grown to 56, and 34 additional cities had definitely decided to adopt electricity for tramway service. Of these 34 it was expected that 8 would be in operation before the end of 1897, so that the total number of cities using electric traction at the beginning of the present year is 64. The existing roads have more than 600 miles of track, of which about one-half is double; and, with the exception of 11 miles of underground road in Berlin, and less than 75 miles of storage-battery system, this is all overhead trolley.

THE ENGINEERING INDEX

INTRODUCTORY

This Index is issued separately from the Magazine printed on one side of the paper only, and is supplied to subscribers for THE ENGINEERING MAGAZINE at a nominal charge of fifty cents a year to cover cost. In this form it meets the exact requirements of those who desire to clip the items for card-index purposes.

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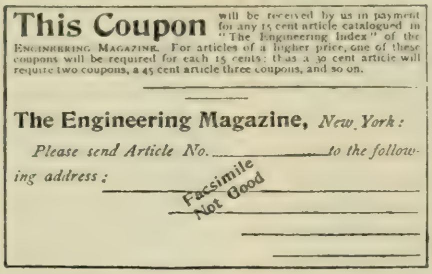

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

American Architect. *w.* Boston, Mass.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila., Pa.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Journal. *m.* London
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m.* New York.
Chautauquan. *m.* Meadville, Pa.
Chem. Met Soc of S. Africa. *m.* Johannesburg, S. A. R.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Elektrotechniker. *b-m.* Vienna.

Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Engineer. *w.* London.
Engineer. *s-m.* New York
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, Tenn.
Engineering and Mining Journal. *w.* New York
Engineering Magazine. *m.* London & New York
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester. *m.* Washington, D. C.
Foundry. *m.* Detroit, Mich.
Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glasers Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades' Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash , D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m.* San Francisco, Cal.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q* New London, Conn.
Journal Political Economy. *q.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc. of Eng. *b-m* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kan.
Locomotive. *m.* Hartford, Conn
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London
McClure's Magazine. *m* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal
Mining Industry and Review. *w.* Denver, Col.
Mining Journal. *w.* London.
Mitt. aus d. Kgl. Tech Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. Stuttgart.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington, N. Z.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *q.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway & Engineering Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York
Revue de Mécanique. *m.* Paris.
Revue Technique. *b-m.* Paris.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerisches Bauzeitung. *w.* Zurich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York
Scientific Am. Supplement. *w.* New York
Scientific Machinist. *s-m.* Cleveland Ohio.
Scribner's Magazine. *m.* New York
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis. Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J
Stone. *m.* Chicago, Ill
Street Railway Journal. *m.* New York
Street Railway Review. *m.* Chicago, Ill
Technology Quarterly. Boston, Mass.
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York
Trans Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill
Western Railway Club, Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Zeitschrift für Lokomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.
Zeitschrift für Instrumentenkunde. *m.* Berlin.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

American Design.

The Tendency of American Design as Exemplified in Recent Buildings. Robert D. Andrews. Comments on classes and types of design. The conspicuous growth of the "classic style" in recent buildings. The Gothic style for cathedrals is largely favored. 2500 w. Arch Rev—Vol. IV. No. VIII. No. 17542 F.

Apartments.

Mechanical Features of the Lenox Apartments, Buffalo, N. Y. The building contains 49 apartments, and is supplied with heat, light and power, and with cold brine circulated through pipes to refrigerating boxes in the kitchens. 1800 w. Eng Rec—Jan. 1, 1898. No. 17510.

Brickwork.

See Civil Engineering, Miscellany.

Church.

The Evangelical Garrison Church at Strasburg. (Die Neue Evangelische Garnison-Kirche zu Strassburg.) Elevation, plans and section of this fine modern example of Gothic church architecture. 2000 w. 1 plate. Deutsche Bauzeitung—Jan. 8, 1898. No. 17843 B.

City Construction.

The City of the Future. Theodore Waters, in *Star Sayings*, St. Louis. On the engineering skill needed by architects of the present, in constructing the tall buildings of cities, especially in foundation work. The testing of grounds, weighing of buildings, &c., is considered. 2200 w. Stone—Jan., 1898. No. 17961 C.

Congressional Library.

The New Library of Congress. Russell Sturgis. An interesting study of the decorative work with brief history of the building, its architecture and plan. Ill. 8700 w. Arch Rec—Jan.-March, 1898. No. 18019 C.

Decoration.

House Decoration. L. A. Shruffrey. Read before the Architectural Assn., England. On the preparation of surfaces, exterior and interior; woodwork, walls, wall-papers. The treatment of natural woods; the deciding on decorations for various rooms, &c. Discussion follows. 10500 w. Builder—Dec. 25, 1897. No. 17590 A.

Domes.

Steel Domes of the Parrott Building and the City Hall at San Francisco, Cal. Illustrated description of the construction giving the general arrangement and construction of the various members. 1600 w. Eng News—Jan. 6, 1898. No. 17572.

Foundations.

The Foundations of the New Post-Office and Government Building at Chicago. Describes the work of building foundations, carried down through the clay to hard material, for this massive and heavy masonry structure. Ill. 2400 w. Eng News—Jan. 27, 1898. No. 18033.

Grain Elevator.

See Electrical Engineering, Power.

Iron Protection.

See Civil Engineering, Miscellany.

Mortar.

See Civil Engineering, Miscellany.

Mural Painting.

Mural Decoration. G. A. Reid. Briefly reviews the past history of wall decoration, and discusses some of the recent work in various lands, and the modern method of decoration. Ill. 2700 w. Can Arch—Jan, 1898. No. 17985 C.

Museum.

The Historical Museum at Berne. (Das Historische Museum in Bern.) Illustrated description of this fine new museum building in Switzerland, with plate of interior view. Two articles. 1500 w. Schweizerische Bauzeitung—Jan. 1, 8, 1898. No. 17838 E.

Roof Construction.

Notes on the Construction of the Weaving-Shed Roof. (Beitrag zur Konstruktion der Sägedacher.) Th. Landsberg. The trusses are united by jointed connection, to vertical frames forming a portion of the walls, or carried down within them. 1000 w. Zeitschr de Ver Deutscher Ing—Dec. 25, 1897. No. 17804 D.

Skeleton Construction.

The Use of Stone in Skeleton Construction. E. McL. Long. States the conditions to be fulfilled in the construction of these buildings, criticizing the deception in giving the building the appearance of solid masonry, and offering suggestions. Ill. 2700 w. Stone—Jan., 1898. No. 17960 C.

Structural Metals.

Effect of High Temperatures on the Strength of Structural Metals. H. K. Landis. The fire problem in steel skeleton buildings makes this a subject of importance. The article reviews tests made by competent authorities. 1100 w. Fire & Water—Jan. 22, 1898. No. 18011.

Tests.

Official Tests of Cast-Iron Columns and Brackets. Part first gives illustrated description of breaking columns through the body. 3000 w. Eng Rec—Jan. 8, 1898. Serial. 1st part. No. 17659.

Tests of the Strength of Brackets on Cast-Iron Columns. Summary of the results of bracket tests from the report of W. W. Ewing, with notes concerning the character of the fractures. 2300 w. Eng News—Jan. 20, 1898. No. 17943.

Theatre.

The Iron Reconstruction of the Variety Theatre at Prague. (Die Eisenconstruction des Varieté-Theaters in Prag.) A valuable description of fireproof theatre construction, with details of iron work. 1800 w. Wiener Bauindustrie-Zeitung—Jan. 6, 1898. No. 17848 D.

Veneer.

Brick-Veneer Construction. Fred T. Hodgson. Discussion of this practice, showing that it is a loss both in economy and efficiency. 1200 w. Br Build—Jan., 1898. No. 18068 C.

HEATING AND VENTILATION.

Central Heating.

Examples of Small Central Heating and Ventilating Plants. (Beispiele Kleinerer Centralheizungs-und Ventilationsanlagen.) Showing large hot air furnace system for warming and ventilation, as applied to a theatre and a charitable institution near Vienna. 2500 w. Wiener Bauindustrie Zeitung—Dec. 23, 1897. No. 17847 D.

English Practice.

English Practice in the Warming and Ventilation of Technical and Art Schools. Paper prepared by Frank Ashwell and revised and edited by D. M. Nesbitt. Describes a mechanical system which is a combination of the plenum and vacuum systems, and discusses briefly the theory of the methods adopted. 7000 w. Trans Am Soc of Heat and Ven Engs—Jan., 1898. No. 18048 D.

Fans.

See Mining and Metallurgy, Mining.

Flues.

Draft Flues for Furnaces. E. C. Moses. Observations on the character of chimney flues, with general conclusions. 1100 w. Heat & Ven—Dec. 15, 1897. Serial. 1st part. No. 17491.

Forced Draft.

Heating and Ventilating Church and Parish Buildings by Forced Draft. B. H. Carpenter. States the conditions to be met and method of obtaining the required results. 1100 w. Trans Am Soc Heat & Ven Engs—Jan., 1898. No. 18047 D.

Gas Heating.

Heating with Gas. J. H. Kinealy. Gives a description of a grate and hot-air furnace, referred to in a paper by F. Foveaux, read before the Pacific Coast Gas Assn. Also quotes from a paper giving some results of experience with gas for heating schools in Germany. Ill. 1700 w. Met Work—Jan. 22, 1898. No. 17959.

Great Britain.

Heating in Great Britain. J. L. Saunders. Comment on the different conditions in the United States and Great Britain, with short account of systems most used. 1400 w. Heat & Ven—Dec. 15, 1897. No. 17492.

Hot Water.

The Hot-Water System for the Heating of Buildings. J. J. Blackmore. Illustrating and describing various systems of piping, boilers and radiators, with regard to the various adaptations to house heating, with data about proportions and performance. 4000 w. Engineering Magazine—February, 1898. No. 18082 B.

Humidity.

The Arid Atmosphere of our Houses in Winter. Henry Barnes. Abstract of paper read before the American Public Health Assn., at Philadelphia meeting. Compares the atmosphere of heated houses with the natural atmosphere, and discusses means for increasing the humidity. 1500 w. Heat & Ven—Dec. 15, 1897. No. 17493.

Old Methods.

Methods of Heating in Olden Time. Sidney Perley. Historical account of early fireplaces and stoves used in various places. 2800 w. Dom Engng—Jan., 1898. No. 17919 C.

Opera House.

Heating Installation in Cazenovia Opera House. Illustrated description of heating and ventilating plant. Direct-indirect radiators. 500 w. Heat & Ven—Dec. 15, 1897. No. 17494.

Pipes.

Proportioning of Circulating Pipes for Steam and Hot-Water Heating Systems. J. J. Blackmore. Examines the rules formulated by different engineers, showing their discrepancies and presents rules which the writer believes will establish safe ratios for all sizes of plants. 2400 w. Trans Am Soc of Heat & Ven Engs—Jan., 1898. No. 18051 D.

Radiators.

A New Type of Hot-Blast Radiator. George I. Rockwood. Describes a new type of radiator designed to produce a forced circulation of steam, and chiefly advantageous to use with steam of low or atmospheric pressure. Ill. 2300 w. Trans Am Soc Heat & Ven Engs—Jan., 1898. No. 18045 D.

Steam Circulation.

Some Experiments in Steam Circulation. John Gormly. Describes the peculiar behavior of the water line, investigations to ascertain the cause, and final remedy. 1000 w. Trans Am Soc of Heat & Ven Engs—Jan., 1898. No. 18046 D.

Steam Heating.

Single Pipe Low Pressure Steam Heating Systems. Mark Dean. Discusses the circuit system giving the requirements of the steam mains and branches, with rules, but emphasizing the need of common sense in the engineer to meet the varying conditions. 1400 w. Trans Am Soc of Heat & Ven Engs—Jan., 1898. No. 18050 D.

Steam Heating of the Buildings and Offices of the Administration of the International Exhibition of 1900, Paris. G. Debesson. States the conditions required, and gives illustrated description with costs. 1000 w. Heat & Ven—Dec. 15, 1897 No. 17490.

Temperature Recorder.

The Beraneck Temperature Recorder. (Der Wärmeschreiber, System Beraneck.) A revolving drum receives the electrically transmitted indications from any desired number of distant thermometers. 1200 w. Gesundheits-Ingenieur —Dec. 31, 1897. No. 17844 B.

Test.

A Test of the Heating and Ventilating Plant, New York State Veterinary College, Cornell University, Ithaca, N. Y. R. C. Carpenter. Gives description of buildings and plant, with report of investigations made and results. The fan system is used controlled by thermostats. Ill. 11500 w. Trans Am Soc of Heat & Ven Engs—Jan., 1898. No. 18044 D.

Ventilation.

Ventilation Practically Considered. Rufus R. Wade. Abridged from a work published for private distribution. Discusses the methods under the heads of natural, mechanical, and by aspiration. 2800 w. San Plumb—Jan. 1, 1898. No. 17554.

• Walls.

The Effect of the Heights of Walls on the Amounts of Heat Transmitted Through Them. J. H. Kinealy. Reviews the experiments made by other investigators and holds that the heat loss of a high wall is greater than that of a lower one of the same kind, area and thickness. 1800 w. Trans Am Soc of Heat & Ven Engs—Jan. 1898. No. 18049 D.

LANDSCAPE GARDENING.

Forestry.

See Municipal Engineering, Water Supply.

Landscape.

The Imaginative Element in Landscape. Sylvester Baxter. Some thoughts on this subject as applied to park development. 2200 w. Am Arch—Jan. 8, 1898. No. 17624.

PLUMBING AND GASFITTING.

Hotel.

Plumbing in the Astoria Hotel. Part first gives general description of the building and outline of water supply and drainage systems. Ill. 2200 w. Eng Rec—Jan. 22, 1898. Serial. 1st part. No. 17965.

Hot-Water Supply.

Mistakes Made in the Erection of Domestic Hot-Water Supply Apparatus. Frederick Dye. Part first discusses English practice, giving instances of bad results due to details of construction. Ill. 2000 w. Heat & Ven—Dec. 15, 1897. Serial. 1st part. No. 17495.

On Heating Water by Steam. Discusses the best means of heating water for use in industrial establishments, and gives rule for finding the weight of steam required to heat a given body of water to the boiling point. 1500 w. Prac Eng—Dec. 31, 1897. No. 17697 A.

Regulations.

Plumbing Regulations of Moline, Ill. A copy of these regulations which are considered in many respects a model. 5400 w. Eng Rec—Jan. 15, 1898. No. 17767.

Ventilation.

Sewer Ventilation. J. W. Hughes. Opposes the use of the intercepting trap, giving reasons. 1400 w. Dom Engng—Jan , 1898. No. 17-918 C.

MISCELLANY.

Ancient Buildings.

Shetland Brochs. Describes the structure and interior arrangement of the Broch of Mousa, one of a class of ancient buildings on this island. 2300 w. Arch, Lond—Dec. 31, 1897. No. 17682 A.

Building Laws.

The Enforcement of Building Laws. Osborne Howes. Read before the Detroit convention of Building Commissioners and Inspectors. Suggests that the board of underwriters of a city impose a penal charge of double rates upon buildings put up in defiance of a building law. 900 w. Arch & Build—Jan. 15, 1898. No. 17740.

Cast-Iron Columns.

The Strength of Cast-Iron Columns. Editorial on the importance of the experiments made by the New York Building Department upon the large testing machine at Phœnixville, Pa. The results show the worthlessness of Gordon's formula as applied to cast iron columns. 2300 w. Eng News—Jan. 20, 1898. No. 17944.

Cement.

See Civil Engineering, Miscellany.

Competitions.

The Lesson of the Pennsylvania Capitol Competition. William Seton Gordon. A review of the facts with the view of discovering what practical conclusions may be drawn for future guidance. 4500 w. Eng Rec—Jan. 1, 1898. No. 17509.

Edinburgh.

The Architecture of Our Large Provincial Towns — Edinburgh. Interesting historical account with illustrated descriptions of old and new architecture. 9500 w. Builder—Jan. 1, 1898. No. 17679 A.

Education.

The True Education of an Architect. Russell Sturgis. The importance of teaching young architects to build, to draw, to model, 6800 w. Atlantic M—Jan., 1898. No. 17979 D.

Elevators.

See Mechanical Engineering, Miscellany.

Lathe Work.

Lathe Work in Interior Decoration. Fred T. Hodgson. Showing how lathe work may be effectively applied to interior finishing. Ill. 1400 w. Can Arch—Jan., 1898. No. 17986 C.

Leaded Glass.

Architectural Sympathy in Leaded Glass. Otto Heinigke. On the faults of stained-glass windows, and the need of the architect, and the study of architectural effect. Ill. 3000 w. Arch Rev—Vol. IV—No. VIII. No. 17541 F.

London Fire.

The Cripplegate Fire. Reports the evidence of the witnesses of the architectural profession regarding the class of buildings, and the use to which they were put, fire protection needed, &c. 5800 w. Engng—Dec. 24, 1897. No. 17607 A.

Melrose.

Melrose Abbey. W. J. Anderson. Illustrated description of this well-known Scottish ruin. 6000 w. Builder—Jan. 1, 1898. No. 17681 A.

Palladio.

Palladio and His Work. Alfredo Melani. Historical account of what is known of this great architect of the sixteenth century, his work and his influence. Ill. 4800 w. Arch Rec—Jan.–March, 1898. Serial. 1st part. No. 18017 C.

Pisa Tower.

The Problem of the Leaning Tower of Pisa. William H. Goodyear. A study of leaning buildings of Italy, the façade of the Cathedral, the tower, and other structures, aiming to give a solution of the problem of construction. Ill. 8500 w. Arch Rec—Jan.–March, 1898. No. 18018 C.

Report.

Report of the Committee on Architecture and Grounds of the Tennessee Centennial Exposition. Extract from the report, containing intelligent criticism of the architectural work. Ill. 3300 w. Br Build—Jan., 1898. No. 18067 C.

Roofs.

Thatched Roofs. Henry Rose. Statistics show that this form of roofing is falling into disuse, but it is still common in country districts. Methods of laying it are given, with its advantages and disadvantages, and its æsthetic qualities. 2300 w. Builder—Jan. 1, 1898. No. 17680 A.

Sanitation.

See Municipal Engineering, Sewerage.

School Buildings.

The School Buildings of New York. John Beverley Robinson. A finely illustrated article on the school buildings of New York, showing the great improvements made, and the evidences of careful thought. 5000 w. Arch Rec—Jan.–March, 1898. No. 18020 C.

Sculpture.

The Angels at Bradford-on-Avon, Wilts, Eng. S. Beale. Describes these examples of early sculpture, and refers to the use made by architects of the forms of angels, because of the ease with which they may be adapted to awkward spaces. Ill. 1500 w. Am Arch—Jan. 22, 1898. No. 17980.

The Sculpture for the Glasgow Art Galleries. Gives the report of the architects and master sculptor on the sculpture and carving, with favorable comment. 5500 w. Brit Arch—Dec. 24, 1897. No. 17614 A.

Tombs.

The Tomb of a Theban Astrologer of the Eighteenth Dynasty. P. Hippolyte-Boussac. Printed in both English and French. Illustrated description of an ancient tomb, especially the paintings which decorate it. 1600 w. Jour Roy Inst of Brit Arctrs—Dec. 4, 1897. No. 17741 B.

Wire Nails.

See Mechanical Engineering, Miscellany.

Woman's Influence.

Influence of Women on Architecture. C. T. Mathews. Reviews noted instances in history where the influence of women has been the inspiration or power that resulted in fine architectural work. 2000 w. Am Arch—Jan. 1, 1898. No. 17560.

CIVIL ENGINEERING.

BRIDGES.

Arches.

Stone Arches of Large Span with Articulated Joints of Lead. An account of some arched bridges built in Wurtemburg by M. Liebbrand, employing lead in the key joints and joints of rupture, with satisfactory results. 800 w. Eng News—Jan. 20, 1898. No. 17947.

Berne.

The Competition for the Lorraine Bridge at Berne. (Concurrenz-Entwurf für die Lorraine-Brücke in Bern.) Devoted especially to an examination of the design which contained a wide span arch of iron and concrete, and which although not finally adopted, received an award. 8000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Jan., 1898. No. 17818 D.

Brooklyn Bridge.

Strength of the New York and Brooklyn Suspension Bridge. Brief discussion as to the increased loads being a cause of danger. 1000 w. Sci Am—Jan. 8, 1898. No. 17555.

Cantilever.

The Cachoeira Bridge, Brazil. Illustrated description of a steel cantilever bridge recently built, especially some of the features adapted to local conditions in which the English methods of work differ from the usual practice in the United States. 1800 w. Eng Rec—Jan. 1, 1898. No. 17503.

Continuous Girder.

The Continuous Arched Girder with Two Joints. (Der Continuierliche Bogenträger mit Zwei Gelenken.) A very full mathematical discussion, with the practical example of the bridge over the Rhine at Constance fully computed. 8000 w. 1 Plate. Oesterr Monatschr f d Oeffent Baudienst—Jan., 1898. No. 17820 D.

East River.

Bridges Over the East River. O. F. Nichols. Read before the Municipal Club of Brooklyn, Jan. 18, 1898. Considers the old bridge, the new bridge, and the next bridge, pointing out what is needed to insure the greatest benefits. 2700 w. Eng Rec—Jan. 22, 1898. No. 17963.

Viaduct.

Competitive Designs for Connecticut Avenue Viaduct, Washington, D. C. A brief statement of conditions governing the work, with illustrated descriptions of designs submitted. 2500 w. Eng News—Jan 27, 1898. No. 18029.

The Riverside Drive Bridge. A New York highway bridge, 1564 feet long, with a 60-ft. carriage-way, and two ten ft. sidewalks. The bridge consists of 25 arch-spans in which particular attention was paid to harmonious outlines. 1000 w. Eng Rec—Jan. 8, 1898. No. 17654.

CANALS, RIVERS AND HARBORS.

Bohemia.

The Status of the Work on the Moldau-Elbe Canal in Bohemia. (Ueber den Stand der Canalisierungs-Arbeiten an der Moldau und Elbe in Böhmen.) With photographs of various sections, and a plate of weir buildings; together with a record of the variations in level of the Moldau at Prague during 1897. 6000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Jan., 1898. No. 17816 D.

Breakwaters.

Breakwater Construction on the American Coast. Louis Y. Schermerhorn. Confined to the construction on the ocean coast and considering the forces through wave action, design, position and general principles; also discussion. Ill. 7500 w. Pro of Engs' Club of Phila—Jan., 1898. No. 17611 D.

Dortmund.

General Meeting of the Society for the Construction of a Canal from Dortmund to the Rhine. (General Versammlung des Vereins für Erbauung eines Kanals von Dortmund nach dem Rhein.) The construction of the canal was strongly urged, and the inadequacy of the existing railway facilities shown. 8000 w. 4 plates. Glückauf—Dec. 18, 1897. No. 17849 B.

Floods.

Mississippi Floods. W. W. Knight. States the conditions that exist along this river, reviewing the work that has been done, and the plans proposed, with brief account of damages. 2000 w. Yale Sci M—Dec., 1897. No. 17545 C.

Harbor Improvement.

Harbors and Waterways. Editorial discussion of improvements made and planned, made necessary by the constantly increasing size of vessels; also inland navigation and related matters. 4300 w. Engr, Lond—Jan 7, 1898. No. 17902 A.

Wharf Improvement and Harbor Facilities. (Outillage et Aménagement des Ports.) A condensed abstract and translation of Mr. Crowell's article in *The Engineering Magazine* of November, 1897. 2500 w. La Revue Technique—Jan. 10, 1898. No. 17823 D.

Jetties.

The Great Training Jetty at the Mouth of the Columbia River, Oregon. Illustrated description of this very successful engineering work. 1700 w. Sci Am—Jan. 15, 1898. No. 17780.

Levees.

Standard Levee Sections. H. St. L. Coppée. Explains the work along the Mississippi and the standards adopted in the various sections. Also gives comparison of the third district levee section with the old American notions and with those used in foreign countries, in order to determine what evolution there has been, and how the practice in various places compares. Tabulated results and many illustrations. 4000 w. Pro Am Soc of Civ Engs—Jan., 1898. No. 18052 F.

Loire.

The Navigation of the Loire. (La Loire Navigable.) An appeal for river improvements in aid of the navigation of the Loire, citing the important commercial and manufacturing interests of France affected thereby. 3500 w. La Revue Technique—Jan. 10, 1898. No. 17824 D.

New York Canals.

Concerning Erie Canal Improvements. Chauncey N. Dutton. Letter offering comments on an editorial on this subject, published in the Jan. 6 issue of this journal, and giving opinions of the writer. 4500 w. Eng News—Jan. 27, 1898. No 18031.

New York's Canal Improvement. Full report of C. W. Adams, State Engineer and G. W. Aldridge, Superintendent of Public Works. Statements concerning work in progress and projected, cost, &c. 11000 w. Sea—Dec. 30, 1897. No. 17489.

Present Status of the New York State Canals Improvements. Statements relating to the progress and cost of the work, from the report of Campbell W. Adams, State engineer of New York, with editorial notes. 2000 w. Eng News—Dec. 30, 1897. No. 17481.

The New York State Canals. Editorial comment on recent developments concerning the estimates of cost of proposed improvements. 1600 w. R R Gaz—Jan. 7. 1898. No. 17565.

What Shall New York Do with its Canals? Editorial discussion of the present situation and the best course to pursue. 2700 w. Eng News—Jan. 6, 1898. No. 17573.

River Regulation.

Notes on the Regulation of Rivers with Shifting Channels. (Beitrag zur Frage der Regulierung Geschiebeführender Flüsse.) R. Iszkowiski. Discussing the especial question of the practicability of straightening winding river courses and recovering the land for agricultural purposes. 2500 w. Oesterr Monatschr f d Oeffent Baudienst—Jan., 1898. No. 17819 D.

The Regulation of the Theiss in the Bodrogközer District. (Die Bodrogközer Theiss-Regulierung.) Describing the river improvements intended to prevent the disastrous inundations of an important agricultural district of Hungary by the river Theiss. 3000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Jan., 1898. No. 17817 D.

Seaports.

Our Future Seaports. Archibald A. Schenck. Some information regarding important ports of the United States, and the concessions being made by railroads to reach these ports directly at the coast. 600 w. R R Gaz—Jan. 21, 1898. No. 17957.

Ship Canals.

The Economic Effects of Ship Canals. J. A. Fairlie. Traces the economic effects, showing how, in consequence of the canals, important changes have been made in business machinery, in business methods, in producing and market-ing commodities, and in general economic development. 7500 w. An Am Acad—Jan., 1898. No. 17529 G.

Tidal Deposits.

The Tidal Marshes of the Bay of Fundy. Describes the action of the tides which have formed the salt marshes of New Brunswick and Nova Scotia. 2000 w. Eng News—Dec. 30, 1897. No. 17477.

IRRIGATION.

Colorado.

Peculiar Features of Irrigation Engineering in Colorado. H. A. Crafts. A fully illustrated account of irrigation methods in Colorado with details of ditch construction and data as to cost, capacity, and operation. 3500 w. Engineering Magazine—February, 1898. No. 18083 B.

Dam.

California's Big Dam. Helen H. Gardener. Interesting information and popular account of the great Morena Dam, near San Diego, and its construction. 2500 w. Harper's Wk—Jan. 8, 1898. No. 17578.

Falling Shutters.

Falling Shutters, Godavery Anicut. J. C. Larminie. Describes the falling shutters substituted in lieu of a permanent raising of the Anicut by two feet. Ill. 600 w. Ind Engng —Dec. 18,1897. No. 17924 D.

Progress.

Recent Progress in Irrigation. F. H. Newell. Read at Irrigation Congress, at Lincoln, Neb. Recent development has been along the line of increase of area cultivated. Very few large systems have been constructed. The small works have usually been successful. Discusses why large corporate enterprises often fail. 2800 w. National Advocate (San Francisco)—Dec., 1897. No. 17987.

MISCELLANY.

Bending.

The Stresses in Stone or Concrete Plates Subjected to Bending. (Die Spannungen in auf Biegung Beauspruchten Stein- oder Betonplatten.) A mathematical investigation by Prof. Hofmann, with application to practical examples. 1000 w. Deutsche Bauzeitung—Dec. 22, 1897. No. 17842 B.

Brickwork.

Brickwork Tests. Report on the Third Series of Experiments by William C. Street and Max Clarke, with Appendices by Professor Unwin. Tabulated results are given with other information of interest. 6000 w. Jour Roy Inst of Brit Archs—Dec. 18,1897. No. 18001 B.

Cement.

The Chemical Constitution of Portland Cement. On the experiments of Messrs. S. B. and W. B. Newberry, giving conclusions and comparing them with conclusions reached by Le Chatelier. 1800 w. Engr, Lond—Dec. 24, 1897. No. 17592 A.

Drainage.

Benefits of Tile Drainage. E. M. Pike. Read at meeting of Illinois Clay Workers Assn. Sets forth the advantages of tiling and explains how it improves the condition of the soil. 1800 w. Brick—Jan., 1898. No. 17724.

The Drainage Works in the Delta of the Niemen. (Die Schöpfwerke im Memel-Delta.) Describes the use of electric power to recover a large tract of land at the mouth of the Niemen. The first installment contains an account of the central electric station. Serial. Part 1. 2000 w. Der Elektro-Techniker—Dec. 31, 1897. No. 17879 B.

Earthwork.

Some Practical Applications of the Mass Curve in Earthwork Computations. Walter L. Webb. Reviews the fundamental features of this method for the computation of earthwork, with applications of the curve. Discussion. Ill. 5800 w. Pro of Engs' Club of Phila—Jan., 1898. No. 17613 E.

Iron Protection.

Paints for the Protection of Iron Work. A. H. Sabin. Condensed from a lecture delivered before the students of the Rensselaer Polytechnic Inst. Shows the danger from rust, discusses the treatment necessary, giving directions and suggestions. 2800 w. Eng News—Jan. 27, 1898. No. 18035.

The Preservation of Iron from Rust. Discusses whether there is any need for the use of mixtures containing pigments or linseed oil. Shows the pigment possesses no protective value, and calls attention to tar, pitch and asphaltum as rust preventers. 4000 w. Engr, Lond—Jan. 14, 1898. No. 17988 A.

Library.

An Opportunity for the American Society of Civil Engineers. Editorial. Suggests that an extension should be made to the scope and usefulness of the Society's library, making it of great value to the engineering profession. 1600 w. Eng News—Jan. 13, 1898. No. 17716.

Monier System.

The Influence of Temperature Changes on Concrete-Iron Constructions. (Einfluss von Temperaturschwankungen auf Beton-Eisenconstructionen.) J. Hermanek. A mathematical discussion, showing that no injurious stresses are likely to occur from expansion and contraction of the metallic portion of work executed in the Monier system of concrete and iron. 1000 w. Zeitschr d Oester Ing u Arch Ver—Dec. 17, 1897. No. 17810 B.

Mortar.

Study of the Ultimate Constitution of Hydraulic Mortar. (Etudes sur la Constitution Intime des Mortiers Hydrauliques.) R. Feret. An account of tests of Portland cement mortars, showing the importance of using fine sand and securing thorough admixture. Compression tests are considered most reliable. 20000 w. Bulletin de la Société d'Encour—Dec., 1897. No. 17835 G.

Quarry.

The Quarries of St. Triphon. (Les Carrières de St. Triphon.) Description of marble quarries in the Rhône valley in Switzerland, with an account of the use of the endless wire saw, and electric traveling crane. 1500 w. Schweizersche Bauzeitung—Jan. 1, 1898. No. 17839 B.

Review.

Civil Engineering. Editorial review of the outlook for this profession in England, and the work of the past year. Also considers work to be done in other lands. 5800 w. Engr, Lond—Jan. 7, 1898. No. 17900 A.

Roads.

Some Considerations About Roads. N. S. Frost. Extracts from a paper read at a recent meeting at Petaluma, Cal. On the direction of roads, grades, drainage and surface. 1500 w. Min & Sci Pr—Jan. 8, 1898. No. 17739.

Some Features of Stone Road Construction. Benjamin Franklin. Discusses (1) The use of clay or loam as a " binder " on stone roads ; (2) The thickness of stone roads ; (3) The comparative merits of Macadam and Telford roads. Also followed by general discussion. 8300 w. Pro of Engs' Club of Phila—Jan., 1898. No. 17612 D.

Proposed Road Through the Sty Head Pass. An account of a new coaching road to be built from Borrowdale to Wasdale, England, which will open up some of the finest scenery of the Lake District. 1200 w. Engr, Lond—Dec. 31, 1897. No. 17694 A.

Roof Construction.

See Architecture & Building, Construction.

Search Light.

A Portable Search-Light Apparatus. (Projecteur Lumineux Portatif.) A small sphere of platinum in the focus of a parabolic reflector is raised to white incandescence by the blast of a hydrocarbon vapor. The apparatus is especially applicable to military, mining, and engineering work. 1000 w. La Revue Technique—Jan. 10, 1898. No. 17826 D.

Spirit Leveling.

Spirit Leveling of the United States Geological Survey. Herbert M. Wilson. A statement of the work of the field parties engaged in the topographic mapping of the United States Geological Survey, in the careful spirit-leveling conducted by them. 15000 w. Pro Am Soc of Civ Engs—Jan., 1898. No. 18053 F.

Structural Metals.

See Architecture & Building, Construction.

Tests.

See Architecture & Building, Construction.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

Africa.

Trading Stations of the West Coast of Africa. Summary of information regarding some of the trading stations in French and Portuguese Congo on the West Coast of Africa. 1600 w. Bd of Tr Jour—Jan., 1898. No. 18061 A.

Asiatic Trade.

America's Opportunity in Asia. Charles Denby, Jr. Calls attention to the possibilities, aiming to arouse interest and to point out measures which would benefit United States exporters. Considers that we have all the advantages and need only to act. 3000 w. N Am Rev—Jan., 1898. No. 17533 D.

Bohemian Exports.

Bohemian Exports to the United States. Some points of interest to American manufacturers, giving brief suggestions concerning the introduction of American goods, and other information. 1100 w. Cons Repts—Jan. 27, 1898. No. 18043 D.

British Columbia.

British Columbian Laws as to Trading Corporations. A summary of the provisions in regard to extraprovincial companies. 600 w. Cons Repts—Jan. 4, 1898. No. 17580 D.

The Trade and Industry of British Columbia. Information from the annual report of the British Columbia Board of Trade, about mining, fisheries, sealing, lumber, agriculture, etc. 1200 w. Bd of Tr Jour—Jan., 1897. No. 18063 A.

British Trade.

Present Condition of British Trade. Commenting on the unfortunate conditions affecting the trade and quoting from articles published in British papers. 2800 w. Cons Repts—Jan., 1898. No. 17734 D.

China.

German Occupation of Chinese Territory. Discusses the resources of the region and the possibilities for United States trade. 1500 w. Cons Repts—Jan. 13, 1898. No. 17730 D.

Commercial School.

Commercial High School for Magdeburg. Reports the steps being taken in Germany, to advance the higher education of the merchant class in branches of their occupation. It is proposed to establish a state commercial high-school at Magdeburg, Prussia. 1200 w. Cons Repts—Jan. 15, 1898. No. 17752 D.

Competition.

American Competition in Europe. A review of the progress of American trade, and of special branches that have undertaken to supply the demand, with discussion of the effects, and the means of advancing American interests. 3200 w. Cons Repts—Jan. 18, 1898. No. 17912 D.

American Competition in the World's Iron Trade. Richard Moldenke. Condensed translation of address of E. Schroedter, discussing the growth of the American iron production and the invasion of foreign markets, with brief comments. 2700 w. Ir Trd Rev—Jan. 6, 1898. No. 17620.

Future Supremacy in the Iron Markets of the World. J. Stephen Jeans. In this paper Mr. Jeans discusses the conditions affecting the economical value of finished products in different countries. The prediction is made that the United States will become a larger seller and smaller buyer and ultimately become the richest country in the world. 5000 w. Engineering Magazine—February, 1898. No. 18084 B.

Duties.

Peruvian Duties Payable in Gold. Translated copies of a law providing for the payment of duties in pounds sterling, gold. 600 w. Cons Repts—Jan. 7, 1898. No. 17584 D.

Export Trade.

Charles Davis on Developing an Export Trade. From a paper read at a complimentary dinner at the Manufacturers' Club of Cincinnati. Points out the defects of the United States trade, discussing the subject under heads of politics and business, a foreign commercial policy, over confidence, trading and exporting companies, the consular service, foreign languages, and lack of commercial marine. 3000 w. Ir Age—Jan. 20, 1898. No. 17939.

Failures.

Failure Statistics and Their Meaning. Tabulated statistics of failures classified for use, with explanation of work done by the Bradstreet Co., and its value. 7500 w. Bradstreet's—Jan. 22, 1898. No. 17973.

Germany.

Industrial Advance in Germany. Michael G. Mulhall. Considers the development of the last 20 years, the increase in population and energy; the agriculture, forestry, manufactures, hardware, sugar, mining, shipping, railways, and banking; the wealth and finances; attributing all to the advanced state of instruction in every part of the empire and among all classes of people. 3500 w. N Am Rev—Jan., 1898. No. 17534 D.

India.

False Trade Descriptions in India. Report of fraudulent importations. 2000 w. Bd of Trd Jour—Jan., 1898. No. 18062 A.

Interstate Commerce.

See Railroad Affairs, Transportation.

Japan.

Japan's Trade. Information from the report of Byron Brenan, issued by the English Foreign Office, with suggestions for extending British trade. 4500 w. Ind & Ir—Dec. 31, 1897. No. 17683 A.

The Industrial Movement in Japan. Caspar Whitney. General remarks on the activity and achievements of the past 25 years. Ill. 2000 w. Harper's Wk—Jan. 8, 1898. No. 17579.

Kongo Free State.

Trade Regulations and Taxes in the Kongo Free State. A summary of the condition of affairs governing trade at the present day. Cons Repts—Jan. 19, 1898. No. 17910 D.

Petroleum.

Russia's Petroleum Export to Germany and Austria-Hungary, and New Caucasian Oil Fields. F. Thiess. Translation from the German. Shows that Germany imports almost exclusively from the United States, and states that Russian oil men are making every effort to secure this market for their products. Gives information of new oil discoveries. 500 w. Am Mfr & Ir Wld—Dec. 31, 1897. No. 17500.

Prices.

Comparative Prices of 108 Staple Articles, Raw and Manufactured Products, Produce, Cattle and Meats. Tabulated information showing fluctuations in quotations from October 1, 1894, to January 1, 1898. 2500 w. Bradstreet's—Jan. 15, 1898. No. 17745.

Review.

Encouraging Results of the Business Year. Review of the year 1897, showing it to have been quite satisfactory. A larger aggregate of business in the country as a whole than any year since 1892. Detailed reports of the year's trade in the leading cities of the United States are given. 6000 w. Bradstreet's—Jan. 1, 1898. No. 17499.

Rubber.

Higher Prices for Mechanical Rubber Goods. Reports a resolution passed by the Mechanical Rubber Mfrs. Assn., ordering an advance of 10% on special and listed rubber goods and cotton hose. 1400 w. Ind Rub Wld—Dec. 10, 1897. No. 17537 D.

Importations of India-Rubber During 1897, in Tons. Tabulated statement from advance sheets furnished by Henry A. Gould & Co., of New York. 200 w. Ind Rub Wld—Jan. 10, 1898. No. 17968 D.

Offieial Statistics of India-Rubber and Gutta Percha. Tabulated statements of imports and exports for the year ending June 30, 1897. 900 w. Ind Rub Wld—Jan. 10, 1898. No. 17967 D.

Tea.

Tea Trade of Formosa. Information regarding this subject with review of the season of 1897. 2000 w. Cons Repts—Jan. 6, 1898. No. 17623 D.

Technical Schools.

Technical Merchant Schools. On the efforts being made in Germany to improve the business education of the people, giving extracts from article published in the *London Standard*. 2000 w. Cons Repts—Jan., 1898. No. 17736 D.

Trade-Marks.

Labels and Trade-Marks in China. An explanation of the importance of trade-marks, especially in China, where the superstitions of the people are often offended by the design or color. 1000 w. Cons Repts—Jan. 11, 1898. No. 17622 D.

United States.

Commercial Superiority of the United States. Worthington C. Ford. A protest against the usual method of obtaining commercial statistics, and showing the advantage possessed by the United States by reason of its agriculture, with discussion of other points of importance. 3300 w. N Am Rev—Jan., 1898. No. 17535 D.

Venezuela.

Venezuelan Laws as to Transit Traffic with

Colombia. Substance of the laws in regard to goods shipped in transit to Colombian ports. 2200 w. Cons Repts—Jan. 5, 1898. No. 17581.

Yokohama.

The Trade of Yokohama in 1896. Digest of the report of the British consul concerning the extent and growth of the trade. 1900 w. Engng—Dec. 31, 1897. No. 17691 A.

CURRENCY AND FINANCE.

Currency Reform.

Plans for Currency Reform. Charles A. Conant. A comparison of President McKinley's plan for reform, the scheme of Secretary Gage, and the work of the monetary commission. 6000 w. Am Rev of Revs—Jan., 1898. No. 17569 C.

German Markets.

The Financial Markets of Germany. Raphael-Georges Levy. From the French *Revue des Deux Mondes*. Reviews the rapid progress in Germany, with the view of ascertaining the cause of her success, and how far her methods may be used under differing circumstances. 3000 w. Chau—Feb., 1898. No. 18025 C.

Metal Market.

See Mining and Metallurgy, Miscellany.

Monetary Commission.

Report of the Monetary Commission. An unabridged copy of the report giving a clear statement of existing financial conditions and the changes needed. 13000 w. Bankers' Mag, N. Y.—Jan., 1898. No. 17782 D.

The Report of the Monetary Commission. Report of the salient features of the plan of reform submitted. 3500 w. Ir Age—Jan. 6, 1898. No. 17577.

Russia.

Russia's Currency Reform. An account of the movement and the conditions leading to the establishment of the gold standard. 1000 w. Bradstreet's—Jan. 15, 1898. No. 17744.

Tariff.

Tariff Changes and Customs Regulations. Russia, Belgium, Germany, France, Portugal, Spain, Switzerland, United States, Mexico, Guatemala, Ecuador, Uruguay, Grenada and Cape Colony. 5000 w. Bd of Trd Jour—Jan., 1898. No. 18064 A.

GOVERNMENTAL CONTROL.

Child Labor.

The Illinois Child-Labor Law. Florence Kelley. Read before the International Assn. of Factory Inspectors, at Detroit. A statement of the present law in this state and the need of further legislation. 4800 w. Am Jour of Soc—Jan., 1898. No. 17763 D.

Municipal Ownership.

Objections to the Municipal Ownership of Public Works. T. Carpenter Smith. A discussion of this much-mooted question, especially in regard to the municipal ownership of electric-lighting plants, viewed from the standpoint of the electrical engineer, and taking the adverse position to city control. 4000 w. Engineering Magazine—February, 1898. No. 18079 B.

Ownership.

Government Ownership and Operation of Railroads. Extract from an open letter by E. P. Ripley discussing this question, and showing that private enterprise has proved more satisfactory. 2400 w. Ry & Engng Rev—Jan. 22, 1898. No. 18024.

LABOR.

Engineering Strike.

London Engineers' Dispute. The Strike for a Forty-eight Hours' Week. Address of Sir Benjamin Dobson, of Dobson and Barlow, on the question at issue, discussing various points claimed by the employers. 5500 w. Bos Jour of Com—Jan. 8, 1898. No. 17641.

The End of the Conference. Editorial discussion of the situation, and the rejection of the employers' second proposals. 2000 w. Engng—Dec. 31, 1897. No. 17690 A

The Plevna of Labor. Anon. Reviews the various points under dispute in this struggle, and the changes that have developed in its progress. Generally in sympathy with the employés. 5300 w. Contemporary Rev—Jan., 1898. No. 17711 D.

Free Labor.

The Protection of Free Labor. Brief explanation of the object of the Free Labor Protection Assn., of England, and information concerning it. 700 w. Transport—Jan. 14, 1898. No. 18002 A.

Jewish Workman.

The Jewish Workman. John A. Dyche. A contribution to the subject of alien immigration, answering charges made against the Russian Jew. 7800 w. Contemporary Rev—Jan., 1898. No. 17710 D.

Machinery.

Labor-Saving Machinery. Thomas L. Wilkinson. A discussion of labor-saving machinery in reference to the displacement and expansion of labor, showing it to be mutually beneficial to labor and capital. 2500 w. Min Ind & Rev—Jan. 6, 1898. No. 17665.

Negro Labor.

The Labor Unions and the Negro. John Stephens Durham. The relations of the unions to the colored race are discussed, and the effect of the obstructions preventing its development. 6000 w. Atlantic M—Feb., 1898. No. 17978 D.

Ticket Brokerage.

See Railroad Affairs, Transportation.

Working Hours.

The Hours of Work of Women and Children. Florence Kelley. Reviews the position taken in various parts of the United States, showing that improvement is needed. 1400 w. Chau—Jan., 1898. No. 17498 C.

MISCELLANY.

Accidents.

Protection to Workingmen. (Arbeiterschutz.) A statistical report of the Journeymen's Association, giving much information as to the protection of workingmen in Germany against accidental injury. Data are given up to 1897, with comparisons for the ten years between 1885 and 1895. 4000 w. Glaser's Annalen—Jan. 1, 1898. No. 17815 D.

Montreal.

Incomes, Wages, and Rents in Montreal. Herbert Brown Ames. Data concerning the industrial conditions of this city. 4800 w. Bul Dept of Labor—Jan., 1898. No. 18000 D.

Negro.

The Negroes of Farnsville, Virginia: A Social Study. W. E. Burghardt Du Bois. The first of a series of investigations of small, well-defined groups of negroes in various parts of the country, with the object of ascertaining their real condition. 13000 w. Bul Dept of Labor—Jan., 1898. No. 17999 D.

Patents.

Reforms in the Patent Laws. From report issued by a committee of the National Assn. of Mfrs. of the U. S. Part first considers annuities on U. S. patents; and requiring working and annuities from foreigners, with opinions from letters in relation to this subject. 3000 w. Ir Age—Jan. 13, 1898. Serial. 1st part. No. 17717.

Report.

President's Report to the Manufacturers' Association. Theodore C. Search. Extract dealing with exports, the shipping question, the Nicaragua Canal, the creation of a Department of Commerce and Industry, sample warehouses, &c. &c. 6800 w. Ir Age—Jan. 27, 1898. No. 18042.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Chlorine.

Chlorine from Electricity. A description of what is known as the Rhodin process, by which a saturated solution of common salt can be decomposed in such a manner that chlorine shall be given off at one pole, and sodium at the other. 1300 w. Aust Min Stand—Dec. 9, 1897. No. 17921 B.

Conductivity.

The Conductivity of Solutions of Certain Salts in Pyridin. (Leitfähigkeit von Lösungen einiger Salze in Pyridin.) Drs. Laszczynski and Gorski. Describing experiments on solutions of salts of potassium, sodium, lithium, &c., in pyridin, with notes on the results as to conductivity and decomposition. 1500 w. Zeitschr f Elektrochemie—Dec. 20, 1897. No. 17874 B.

Electrolysis.

Studies in the Electrolytic Separation of Metals. (Studien über die Electrolytische Trennung von Metallen.) N. Revay. Giving details of the separation, by electrolysis, of copper from silver, from mercury, and from arsenic. Serial. Part 1. 1800 w. Zeitschrift f Elektrochemie—Jan. 5, 1898. No. 17876 B.

The Electrolysis of Solutions of Common Salt. Reports the causes of different values reached in investigations made, as explained by Prof. Lorenz, of the Zurich Polytechnic in article published in the *Zeits. f. Elektrochemie.* 600 w. Elect'n, Lond—Dec. 31, 1897. No. 17678 A.

The Electrolytic Separation of Copper from the Group of Positive Metals. (Elektrolytische Scheidung des Kupfers von der Gruppe der Positiven Metalle.) Dr. B. Neumann. A discussion of the technical methods of separating copper from nickel, cobalt, iron and zinc by electrolysis. Serial. Part 1. 3000 w. Zeitschr f Elektrochemie—Jan. 5, 1898. No. 17877 B.

The Electrolytic Winning of Zinc. (Verfahren zur Electrolytischen Zinkgewinnung.) Dr. C. Hoepfner. Giving precautions and suggestions to aid in the application of the electrolytic separation of metallic zinc from the ore on a commercial scale. 1000 w. Der Elektro Techniker—Dec. 15, 1897. No. 17880 B.

LIGHTING.

Brooklyn.

The Edison Electric Illuminating Co. of Brooklyn—Its Development and Its Present and Future Work. Jos. Wetzler. History of the work and equipment of this company. Describes the older stations, and also this latest three-phase system and the great Union Station. Ill. and map. 7200 w. Elec Eng, N. Y.—Jan. 6, 1898. No. 17699.

Efficiency.

The Present Efficiency of Incandescent Lamps. John E. Randall. Read before the Northwestern Elec. Assn., at Milwaukee. Part first reviews tests made, and history of work done, and discusses the points on which the quality, as an illuminant, depends. 1200 w. Elec Wld—Jan. 29, 1898. Serial. 1st part. No. 18074.

Enclosed Arc.

Enclosed Arc Lamps. (Ueber Bogenlampen mit Eingeschlossenem Lichtbogen.) Describes photometric tests of the Jandus enclosed arc lamp, with curves of photometric intensity and tables of results. 7500 w. Elektrotech Zeitschr—Dec. 16, 1897. No. 17862 B.

The Enclosed-Arc Lamp. William H. Freedman. Illustrates and describes the mechanism, regulation, etc.; the life of the carbons, intensity and distribution of light, advantages and disadvantages. 2400 w. Am Elect'n—Jan., 1898. No. 17550.

Central Station.

See Electrical Engineering, Power.

Counter E. M. F.

Counter E. M. F. in the Electric Arc. Editorial discussion of views of various experimenters, especially criticizing the methods of research by which the conclusion that the counter E. M. F. does not exist, has been reached by two experimenters of the United States. 2400 w. Elect'n, Lond—Dec. 31, 1897. No. 17677 A.

Electric Beacon.

Testing an Enormous Electric Beacon. Describes the electric beacon known as the Lepoute "bivalve" being tested at Tompkinsville, Staten Island, N. Y. Ill. 600 w. Elec Wld—Jan. 15, 1898. No. 17722.

Glasgow.

Electric-Light Installation at the Western Infirmary, Glasgow. Illustrated detailed description. 2300 w. Elec Eng, Lond—Jan. 7, 1898. No. 17905 A.

Isolated Plant.

Power Plant of the Roman Catholic Protectory, Philadelphia. Illustrated description of the mechanical plant for lighting a large group of buildings. 1300 w. Eng Rec—Jan. 8, 1898. No. 17660.

Japan.

Some Japanese Electric Light Stations. Brief illustrated description of outfits of Japanese make, giving exterior and interior views. 600 w. Power—Jan., 1898. No. 17625.

Lamp.

See Mining and Metallurgy, Mining.

Lamp Renewal.

The Renewal of Burnt Out Incandescent Lamps. (Die Verwerthung Ausgebrannter Glühlampen.) Describes the various methods which have been proposed for restoring burnt out filaments, none of which is found to pay. The latest method of Becher, of Vienna, is the most promising, and uses a lamp with a long neck which can be cut and a new filament inserted. 1500 w. Elektrotech Zeitschr—Dec. 23, 1897. No. 17865 B.

New Orleans, La.

The New Station of the Edison Electric Co., of New Orleans, La. Illustrated detailed description. 2300 w. Elec Eng, N. Y.—Jan. 20, 1898. No. 17935.

Profit.

Electric Lighting for Profit. Alexander Dow. Paper read before the Northwestern Electrical Assn., with discussion. Gives the writer's opinions on the profits, rates, business methods and general needs of the electric-lighting business. 4800 w. Elec Wld—Jan. 29, 1898. No. 18072.

Vacuum Tubes.

Tesla's Latest Advances in Vacuum-Tube Lighting. Nikola Tesla. Experiments on the application of tubes of high illuminating power to photography and other purposes. Ill. 1000 w. Elec Rev, N. Y.—Jan. 5, 1898. No. 17558.

POWER.

Alternators.

Unipolar Self-Exciting Alternators. J. L. Routin. Translated from *L'Eclairage Electrique*. Describes an arrangement by which a generator may operate without the help of a rectifying commutator. 700 w. Elec, N. Y.—Jan. 26, 1898. No. 18027.

Burglar-Proof Safe.

An Electrically Operated Burglar-Proof Safe. Illustrated description of the construction and operation of a safe for the protection of the costly tabernacle for the sacrament in St. Augustine's Church, Brooklyn, N. Y. 600 w. Elec Wld—Jan. 15, 1898. No. 17723.

Central Station.

Combined Light and Power Plants. (Ein Beitrag zur Frage der Zusammenlegung von Licht- und Kraft-Werken.) Showing by diagrams of the relative demand at different hours, the advantage of using the same station for both kinds of service. 1000 w. Zeitschr f Elektrotechnik—Dec. 15, 1897. No. 17871 B.

The Factors which Control the Profitableness of Central Electric Stations. (Ueber die Faktoren welche die Rentabilität der Elektricitätswerke Beeinflussen.) With diagrams showing the subdivisions of cost and relative efficiency. German and English plants are compared. Two articles. 5000 w. Elektrotech Zeitschr—Dec. 23, 30, 1897. No. 17866 E.

Circuit Breakers.

Circuit Breakers and Their Use in Power Transmission. W. H. Tapley. Considers in detail the protection demanded by a large manufacturing plant using individual motors as power supply, and claims the demands have been met in the modern circuit breakers. 3300 w. Elec Eng N. Y.—Jan. 27, 1898. No. 18037.

Coal Cutter.

See Mining and Metallurgy, Coal and Coke.

Conductors.

Notes on the Cost of Conductors for the Transmission of Electrical Power with High Voltage Currents. M. P. Boucherof in *La Lumière Electrique*. A discussion of the problem of determining the cost of transmission. 800 w. Prac Eng—Dec. 31, 1897. No. 17698 A.

Cranes and Lifts.

Electric Lifts and Cranes. H W. Raven-Shaw. Read before the Institution of Civil Engineers, (England) March 30, 1897. Considers the electrical and mechanical problems in the application of electric motors to working lifts and cranes, and describes some methods by which they have been solved. Ill. 3000 w. Col Guard—Jan. 14, 1898. No. 17995 A.

See also Mechanical Engineering, Shop and Foundry.

Distribution.

A Means of Diminishing the Energy Losses in Alternating Current Transformer Distribution. From *l'Industrie Electrique*. Describes and illustrates the apparatus devised by Alfred Schlatter, which has given good results. 1800 w. Elect'n, Lond—Jan, 14, 1898. No. 18009 A.

The Elements of a Theory of Distribution. (Elemente einer Theorie der Schaltungen.) Arthur Wilke. A theoretical and mathematical discussion of the fundamental principles of electrical distribution. 5000 w. Serial. Part 1. Zeitschr f Elektrotechnik—Dec. 15, 1897. No. 17870 B.

Dynamos.

Some Practical Points on the Design of a Shunt Dynamo. V. Zingler. Attempts to show

how a dynamo may be calculated from first principles so that it may be put in the shops, and so that the winding as specified by the calculations will actually go on. 1400 w. Elec Rev, Lond—Jan. 7. 1898. Serial. 1st part. No. 17906 A.

Electric Driving.

Electricity in Mining and Workshops. (Die Elektricität im Bergbau und Hüttenbetrieb.) With especial reference to the applications of continuous and polyphase currents, and illustrations of generators and motors. 4500 w. Stahl und Eisen—Jan. 1, 1898. No. 17853 D.

Electric Locomotive.

See Street and Electric Tramways.

Electrical Machinery.

The Electrical Machinery of Brown, Boveri & Co., Baden. A. E. Levin. Illustrated detailed description of works and machinery manufactured. 2500 w. Elec Wld—Jan. 8, 1898. Serial. 1st part. No. 17619.

Elevators.

See Mechanical Engineering, Miscellany.

Exposition.

Dynamos and Motors at the Leipzig Exposition. (Dynamomaschinen und Elektromotoren auf der Leipziger Ausstellung.) With general plan of the exhibiting plants and views of the leading exhibits. 2000 w. Die Elektricität—Dec. 18, 1897. No. 17861 B.

Fans.

See Mining and Metallurgy, Mining.

Generators.

Electric Generators. H. F. Parshall and H. M. Hobart. Part first considers the variety of materials entering into the construction, and the need of testing them, also the methods. Ill. 2000 w. Engng—Jan. 7, 1898. Serial. 1st part. No. 17783 A.

Grain Elevator.

The Great Northern Electric Grain Elevator at Buffalo, N. Y. O. E. Dunlap. Illustrated detailed description of one of the largest structures of its kind, 1500 w. Elec Eng, N. Y.—Jan. 27, 1898. No. 18036.

Haulage.

See Mining and Metallurgy, Mining.

Hydraulic Plant.

A Large Hydraulic Plant at Columbia, S. C. Illustrated description of a plant for generating electricity for street railway, lighting, or industrial purposes. 1400 w. Eng Rec—Jan. 1, 1898. No. 17508.

Locomotive.

See Railroad Affairs, Maintenance of Equipment.

Meters.

The Management of Central Station Meter Systems. Caryl D. Haskins. Considers that meters should always be installed in as small units as possible. Discusses their care and intelligent management and the effect upon revenue. 4500 w. Elec Wld—Jan. 1, 1898. No. 17527.

Motors.

Some Notes on Single-Phase Motors. A. C. Eborall. Classifies and discussess the motors of this type now in the English and Continental markets. Ill. 1500 w. Elec Rev, Lond—Jan. 14, 1898. Serial. 1st part. No. 18013 A.

See Street and Electric Tramways.

Niagara Power.

Niagara Power in Buffalo. Horatio A. Foster. Read before the Real Estate Exchange, Buffalo, N. Y. States briefly what has been done up to date to place the power in condition for use, discussing also how the power will be distributed, cost, &c. 2000 w. W Elect'n—Jan. 8, 1898. No. 17702.

Power Plant.

The Development of Electric Power Stations. (Die Entwicklung der Elektricitätswerke.) Giving an account of the growth of light and power stations in various parts of the Continent, especially in Berlin and Vienna. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 17, 1897. No. 17809 B.

The Rand Central Electric Power Plant. Illustrated description of plant furnishing power for mining purposes. 1100 w. Elect'n, Lond—Dec. 24, 1897. No. 17591 A.

Printing Plant.

The Electric Plant of the Government Printing Office. Illustrated detailed description of the new electric light and power plant in operation at Washington, D. C. 1700 w. Elec Wld—Jan. 15, 1898. Serial. 1st part. No. 17721.

Pumping.

See Mining and Metallurgy, Mining.

Repairs.

See Street and Electric Tramways.

Sparking.

A New Method of Avoiding Sparking in Continuous-Current Machines. J. Fischer-Hinnen. From *Elektrotechnische Zeitschrift.* Remarks on the method known as Ryan winding, and the advantage of its application to motors. Ill. 600 w. Elect'n, Lond—Jan. 14, 1898. No. 18007 A.

A New Method of Preventing Sparking in Continuous Current Generators. (Eine Neue Methode zur Vermeidung der Funkenbildung von Gleichstrommaschinen.) J. Fischer-Hinnen. An improvement on the Ryan method, similar to that of Swinburne. Small auxiliary poles are placed opposite the armature with compensating coils to neutralize the armature reaction. 1200 w. Electrotech Zeitschr—Dec. 30, 1897. No. 17867 B.

Three-Phase Plant.

The Three-Phase Plant of the Tide-Water Oil Company. Illustrates and describes a plant which has been in use two years for the purpose of transmitting power to points where an inflammable mixture of oil fumes and air was likely to occur, and which has been giving as good results as the direct current systems. 1000 w. Elec Wld—Jan. 22, 1898. No. 17926.

Tramway Power.

See Street and Electric Tramways.

Transformers.

Some Laws of Rotary Transformers. J. E. Woodbridge and Charles T. Child. Analytical discussion of certain properties dealing with questions in the practical design of such machines. Part first discusses the single-phase rotary. 2500 w. Elec Wld—Jan. 1, 1898. Serial. 1st part. No. 17518.

Trolley Wagon.

The Caffrey Trolley Road Wagon. W. G. Caffrey. Explains a system of transportation, naming the requisites the writer considers necessary for its success. Ill. 1200 w. Elec Eng, N. Y.—Jan. 20, 1898. No. 17937.

TELEGRAPHY AND TELEPHONY.

Berliner Patent.

"Independent" Telephone Companies and the Berliner Microphone Patent. Full text of a letter issued Jan. 1, 1898, by the Independent Telephone Assn. of America. 1600 w. Elec Eng, N. Y.—Jan. 27, 1898. No. 18038.

Cables.

The Capacity Ratios of Cables. (Die Kapacitätsverhältnisse in Kabeln.) Dr. H. Andriessen. A mathematical discussion of the relations of the various capacities of a cable for different condenser arrangements. The relations of several telephone wires in the same cable are discussed. 3000 w. Elekrotech Zeitschr—Dec. 30, 1897. No. 17868 B.

The Electrostatic Capacity of a Two-Wire Cable. George W. Patterson, Jr. Read at the Detroit meeting of the A. A. A. S. A mathematical study. 700 w. Phys Rev—Nov-Dec., 1897. No. 17709 D.

Coherers.

Discontinuous Electrical Conductors. (Conductibilité des Radioconducteurs ou Conductibilité Electrique Discontinue.) Edouard Branly. A study of a number of substances suitable for use in coherers, and a comparison between their action and that of nerve sensation. 1500 w. Comptes Rendus—Dec. 27, 1897. No. 17830 D

Fire Alarm.

The Evolution of the Fire-Alarm Telegraph. Historical Review. Ill. 1500 w. Fire & Water—Jan. 1, 1898. Serial. 1st part. No. 17548.

Induction Coil.

The Induction Coil of the Würtemberg Telephone System. (Der Fernsprechübertrager der Württembergischen Telegraphenverwaltung.) A flat coil is used with core of stamped iron, the design enabling a coil injured by lightning to be readily replaced. 500 w. Elektrotech Zeitschr—Dec. 23, 1897. No. 17864 B.

Pioneer Work.

The History of the Telephone. George C. Maynard. Review of the pioneer work with Bell's great invention. 1600 w. Elec Rev, N. Y.—Jan. 5, 1898. No. 17559.

Printing Telegraphs.

The Telescriptor and the Zerograph. (Teleskriptor und Zerograph.) Describes two new forms of "long-distance typewriters" recently brought out in Germany. The Zerograph can be operated readily with alternating or polyphase currents. 1800 w. Die Elektrizität—Dec. 4, 1897. No. 17860 B.

Submarine Cables.

Localization of Breaks and Partial Earth Faults in Submarine Cables. Gives a short description of Kennelly's alternative methods, the laws governing the same, and also the modified laws advanced by Mr. Schaefer, and discusses the relative merits of the two tests. 2500 w. Elec Rev, Lond—Dec. 31, 1897. No. 17676 A.

Ocean Cables in War Times. Alexander Porter Morse, in the *Albany Law Journal.* Gives the number and extent of ocean cables, and shows that the United States would be at a great and embarrassing disadvantage in the event of war. 800 w. W Elect'n—Jan. 8, 1898. No. 17701.

Synchronograph Tests.

Tests of the Synchronograph on the Telegraph Lines of the British Government. Albert Cushing Crehore and George Owen Squier. Abstract of a report to the Postmaster-General of the United States, read before the Franklin Inst. A description of these trials and remarks on the results especially in connection with the Wheatstone receiver. 3800 w. Elec Wld—Jan. 29, 1898. No. 18071.

Telephony.

The Future of the Telephone. F. Jarvis Patten. Reviews the development of the telegraph, and compares the history of the telephone, predicting that the next step will be the perfecting of the telephone repeater, thus making possible telephonic communication at any distance. 1700 w. Elec Wld—Jan. 1, 1898. No. 17521.

The Past Year's Advance in the Art of Telephony. Kempster B. Miller. In the United States, 250 patents for alleged improvements were granted. Reviews some of the more important. 2500 w. Elec Wld—Jan. 1, 1898. No. 17519.

Wireless Telegraphy.

Telegraphing Without Wires. Ernesto Mancini. Translated from the Italian *Nuova Antologia*. Reviews the work that has been done in this field and the degree of success attained. 2700 w. Chau--Feb., 1898. No. 18026 C.

Wireless Telegraphy. Edwin J. Houston and A. E. Kennelly. Reviews the work in this field and the results thus far attained. 2200 w. Elec Wld--Jan. 1, 1898. No. 17520.

MISCELLANY.

Battery.

Concerning Galvanic "Deposition" Batteries. (Ueber Galvanische "Fällungs" Elemente.) R. Lorenz. By "deposition" battery is meant that form in which the products of the chemical decomposition settle to the bottom, leaving the electrolyte in its full activity. One form consists of plates of zinc and of oxid of copper in a solution of common salt; the hydroxid of zinc is thrown down. 2500 w. Zeitschr f Elektrochemie—Jan. 5, 1898. No. 17875 B.

How Should Battery Cells Be Tested? Rankin Kennedy. Part first deals with preparations for the tests and methods used. 1600 w. Elec Rev, Lond—Dec. 24, 1897. Serial. 1st part. No. 17596 A.

New Models of the Lalande Oxid of Copper Battery. Illustrated description of important improvements upon the old types. 1000 w. Elec Rev, Lond—Jan. 14, 1898. No. 18014 A.

Capillarity.

Certain Electro-Capillary Phenomena. (Ueber die Kapillar Elektrischen Erscheinungen.) H. Luggin. Describes a number of interesting and novel experiments showing the modifications in capillarity produced by electric currents. 4000 w. Zeitschr f Elektrochemie—Dec. 20, 1897. No. 17873 B.

Clark Cell.

The Clark Standard Cell. Arthur Dearlove. A defence of this cell and explanation of the writer's use of it, and manner of constructing. 1100 w. Elect'n, Lond—Jan. 14, 1898. No. 18008 A.

Code.

The National Electrical Code. A copy of the code as adopted by the National Conference on Standard Electrical Rules, with report and discussions in New York and Chicago. 28000 w. Trans Am Inst of Elec Engs—Nov., 1897. No. 17528 D.

Commutators.

Repairing a "Burnt-Out" Commutator. Norman H. Crowell. Describes the location of the trouble and the treatment. 1400 w. Am Elect'n—Jan., 1898. No. 17552.

Conductors.

Shielded Conductors. W. A. Price. Discusses some of the problems brought out by Mr. Mordey's paper on "Dynamos." Ill. 1100 w. Elec Rev, Lond—Jan. 14, 1898. Serial. 1st part. No. 18015 A.

Electrical Interests.

The Relations between the Customer, Consulting Engineer and the Electrical Manufacturer. S. Dana Greene. Read before the N. Y. Elec. Soc. Gives a short sketch of this industry between 1887 and 1892, shows the necessity for a consulting engineer, giving the writer's views on various subjects of interest. 4200 w. Elec, N. Y.—Jan. 19, 1898. No. 17929.

Electrical Progress.

A Review of American Electrical Progress During the Year 1897. No startling discoveries, but steady advance in means and methods. A review of the most prominent changes. 1700 w. Elec Wld—Jan. 1, 1898. No. 17516.

Electrical Terms.

Practical Electrical Definitions. Louis Denton Bliss. Clear explanation of some of the electrical terms most frequently met with in reading electrical journals. 1300 w. Mach, N. Y. —Jan. 1898. No. 17627.

Electric Apparatus.

High Electromotive Force. John Trowbridge. Describes a large plant for the study of discharges of electricity through gases, and some of the results obtained. 1200 w. Sci Am —Jan. 15, 1898. No. 17781.

Electrolytes.

Surface Travel on Electrolytes. W. E. Fiske and W. D. Collins. Investigations of the availability of Ohm's law for electrolytes when in circuit with alternating currents of high frequency. 900 w. Am Jour of Sci—Jan., 1898. No. 17497 D.

France.

Electrical Industry in France During 1897. J. B. Oudin. Review of progress, devoted particularly to traction and lighting. 2200 w. Elec Wld—Jan. 1, 1898. No. 17517.

Galvanometer.

Construction of a Thomson Astatic Galvanometer. H. S. Webb. Illustrated description of a galvanometer which has proved very useful for laboratory work, and may be made very sensitive. 2400 w. Am Elect'n—Jan., 1898. No. 17551.

On the Best Resistance for a Sensitive Galvanometer. Frank A. Laws. A statement of the usual solution of the problem is given, and a solution under conditions other than those usually imposed. 1200 w. Phys Rev—Nov.-Dec., 1897. No. 17708 D.

Gas Battery.

Electricity Direct from Fuel. C. J. Reed. A criticism of work reported by Dr. Borchers in a paper read before the German Electro-Chemical Society, and published in *Zeitschrift für Elektrochemie*. 2800 w. Elec Wld—Jan. 22, 1898. Serial. 1st part. No. 17928.

Greater New York.

Greater New York and Its Electrical Features. Reviews the many uses of electricity already established and those in prospect, for transportation, lighting, telegraphing and telephoning. Ill. 3300 w. Elec Wld—Jan. 1, 1898. No. 17515.

Gutta Percha.

Gutta Percha. Eugene F. A. Obach. A series of lectures before the Society of Arts. History, general properties, geographical distribution, cultivation, analysis, exports, imports, prices, treatment, &c. Ill. 44000 w. Jour Soc of Arts. Serial. 4 parts. Dec. 24 & 31, 1897. Jan. 7 & 14, 1898. No. 17969 H.

Heat Battery.

Electricity from Coal. C. J. Reed. On the method of Sidney H. Short, giving figures from a patent issued Oct. 13, 1896. 1400 w. Elec Wld—Jan. 15, 1898. No. 17720.

Insulation.

The Insulation of Electrical Testing Instruments. J. Wright. Describes and illustrates several insulators applicable to different conditions. 2000 w. Elec Eng, Lond—Dec. 31, 1897. No. 17675 A.

The Testing of Insulators for High-Tension Service. J. R. Haskin. Describes the manner of testing the insulators for the Niagara-Buffalo transmission line. Ill. 1800 w. Elec Wld—Jan. 22, 1898. No. 17927.

Magnetization.

The Effects of Tension and Quality of the

Metal upon the Changes in Length Produced in Iron Wires by Magnetization. Byron B. Brackett. Reports investigations made, describing apparatus used and general method of working, giving results and conclusions. 6500 w. Phys Rev—Nov.-Dec., 1897. No. 17707 D.

The Magnetic Properties of Tempered Steel. (Propriétés Magnetiques des Aciers Trempés.) Mme. Sklodowska Curie. With carefully plotted curves of the results of a number of experiments with different steels, showing the important influence of the presence of small proportions of other ingredients. Steels containing tungsten or molybdenum developed the highest coercitive force. 1200 w. Comptes Rendus—Dec. 27, 1897. No. 17831 D.

Metering.

Multiple-rate Metering. Eustace Oxley. Illustrated description of new method, or a new system of applying the double-rate method of charging, which has met with great success. 4400 w. W Elect'n—Jan. 8, 1898. No. 17700.

Motion.

Note on the Motion of a Charged Body at a Speed Equal to or Greater Than That of Light. Oliver Heaviside. An argument to disprove the statement that 'it would seem impossible to make a charged body move at a greater speed than light.' 700 w. Elect'n, Lond—Jan. 14, 1898. No. 18005 A.

See also Mechanical Engineering, Miscellany.

Municipal Work.

The Application of Electricity to Municipal Work. F. J. Warden-Stevens. A résumé of the points at which electricity is becoming connected with municipal work, such as lighting, traction, &c. 5600 w. Arch, Lond—Jan. 7, 1898. No. 17911 A.

Electricity in Municipal Engineering. R. B. Owens. Read before the Northwestern Elec. Assn. at Milwaukee. Emphasizes the economy that can often be effected by generating at one point all the power required by a municipality. 1600 w. Elec Wld—Jan. 29, 1898. No. 18-073.

Resistance.

A Simple Form of Current Resistance. (Ueber einen Einfachen Starkstrom Widerstand.) Describes a form of water resistance composed of metal plates in a cemented trough of water. 1200 w. Zeitschr f Elektrotechnik—Dec. 15, 1897. No. 17872 B.

Review.

Electrical Advance in the Past Ten Years. Elihu Thomson. Abstract from the *Forum*. Reviews the condition of the art ten years ago, and traces the advances and new applications of electrical energy. 2000 w. Elec Rev, N. Y.—Jan. 19, 1898. No. 17934.

Electrical Engineering in 1897. A sketch of the work in this field in England, reviewing its various branches. 3000 w. Engr, Lond—Jan. 7, 1898. No. 17798 A.

Rontgen Rays.

Report upon Some Preliminary Experiments with the Röntgen Rays on Plants. G. F. Atkinson. An interesting account of experiments made, showing that while plant tissues absorb the rays quite freely, there are no visible external injuries, and that they produce no easily discernible influence. 3500 w. Science—Jan. 7, 1898. No. 17585.

Storage Battery.

The "Hatch" Secondary Battery. Illustrated description of a storage battery made in Boston, Mass. 500 w. Elect'n, Lond—Jan. 14, 1898. No. 18006 A.

See Street and Electric Tramways.

Tariff.

Load Factor System of Charging for Electrical Energy. W. S. Barstow. Explains a system which claims while affording a uniform tariff, to improve the operating load factor, and gradually reduce the cost of manufacture. 2500 w. Elec Eng, N. Y.—Jan. 13, 1898. No. 17-742.

Windings.

Windings of Polyphase Armatures. J. P. Stone. Illustrated description of how these windings are made, showing that it is rather unessential what type of connections are used as far as behavior and output of machines is concerned. 1200 w. Am Elect'n—Jan., 1898. No. 17549.

X Rays.

Note on the Mechanism of the Discharge of Conductors Struck by X Rays. (Sur le Mecanisme de la Déchargé des Conducteurs Frappés par les Rayons X.) G. Sagnac. Describing experimental investigations into the emission of secondary rays from a metal upon which X rays impinge. 1800 w. Comptes Rendus—Jan. 3, 1898. No. 17834 D.

MARINE ENGINEERING.

British Navy.

Additions to the Navy in 1897. Reviews the warships built and tried during the year. 1700 w. Engng—Dec. 24, 1897. No. 17608 A.

Explosives.

High Explosives and Modern War Vessels. Referring to experiments made on the old battleship Resistance, and the lessons to be learned. Specially studying the destruction wrought by the bursting of shells filled with high-explosives. 1800 w. Engr, Lond—Dec. 24, 1897. No. 17593 A.

Ferry System.

The Ferry System at Glasgow Harbor. Describes the system, dealing only with the cross-ferry steamers, and with the up-and down Clutha steamers traversing three or four miles of the harbor at a uniform fare of 1d. per passenger. Ill. 3000 w. Engng—Dec. 24, 1897. No. 17605 A.

Lifeboats.

Hydraulic Lifeboats. Sydney Walker Barnaby. Paper selected from the Transactions of Inst. of Civ. Engs., England. Describes the latest steam lifeboat which has been built by Messrs. Thornycroft and Company for the South Holland Lifeboat Institution, and which is stationed at the Hook of Holland. Ill. 1700 w. Prac Eng—Dec. 24, 1897. No. 17604 A.

Lighthouses.

The New Lighthouses on Lundy Island. The importance to mariners of this island at the entrance of Bristol Channel, is explained; the old lighthouse and the changes made in it reviewed; and the new lighthouses described. 1300 w. Engng—Jan. 7, 1898. Serial. 1st part. No. 17786 A.

Marine Engines.

The Evolution of the Marine Engine. Osborne Atwater Day. Brief review of progress in engines of ocean-going vessels. 1600 w. Yale Sci M—Dec., 1897. No. 17546 C.

Oil Fuel.

Oil Fuel Experiments on Hydraulic Life Boat "Queen." John Platt. Read before the Washington meeting of the Am. Soc. of Naval Engs. General description with particulars of trials, and drawings of the boiler. 2200 w. Ir Age—Jan. 20, 1898. No. 17940.

Seaports.

See Civil Engineering, Harbors.

Shipbuilding.

Recent Progress in the Building of Merchant and War Ships in Germany. (Neuste Erfolge des Deutschen Handels- und Kriegsschiffbaues.) With description of recent German vessels and illustrations of launches of the Kaiser Friedrich, and Victoria Luise. 4000 w. Stahl und Eisen—Dec. 15, 1897. No. 17851 D.

Rules Adopted by United States Navy Department for Riveting Naval Vessels. Instructions recently issued for the purpose of standardizing the type of rivets used for naval vessels, with general rules for spacing. Ill. 1400 w. Marine Engng—Jan., 1898. No. 17662 C.

Shipbuilding and Marine Engineering in 1897. Reviews the shipbuilding industry of Great Britain and explains the marked decrease in tonnage, &c., with additional information of interest. 4000 w. Engng—Dec. 24, 1897. Serial. 1st part. No. 17609 A.

I. Shipbuilding and Marine Engineering in 1897. II. Shipbuilding Prospects for 1898. Brief review of progress during the last year in Great Britain is given, with editorial on the prospect for the present year. 6000 w. Ind & Ir—Jan. 14, 1898. No. 17991 A.

Shipbuilding as a Productive Industry in Great Britain. James McKechnie. Treating chiefly of the increase of steam and decrease of sail tonnage during the past ten years, with especial reference to the various shipbuilding districts of Great Britain. 3500 w. Engineering Magazine—February, 1898. No. 18078 B.

Torpedo Boats.

Conditions Governing Torpedo Boat Design. R. C. Smith. Reviews the considerations controlling future design, the uses of torpedo-boats and destroyers, and related subjects. 3300 w. N Am Rev—Jan., 1898. No. 17536 D.

Torpedo Destroyer.

H. M. S. Fame, a Recent Type of British Torpedo-Boat Destroyer. Brief illustrated description. 500 w. Marine Engng—Jan., 1898. No. 17661 C.

Tramp Steamship.

First American Steel Tramp Steamship Now Building at Bath, Maine. Illustrated description of a boat designed with great care and much skill. 900 w. Marine Engng—Jan., 1898. No. 17663 C.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Boilers.

A Study of Boiler Types. J. P. Johnston. Read at meeting of Civ. Engs'. Club, of Cleveland, O. Discusses types of boilers; selection of boilers; specifications; uses and abuses; and possibilities. 2500 w. Ir Trd Rev—Jan. 6, 1898. No. 17621.

Steam Generators. (Les Chaudières.) C. Walckenaer. Discussing the circulation in water-tube boilers, with many illustrations of the various constructions, together with a description of the numerous forms of instantaneous steam generators, such as are used on steam motor carriages, &c. Three articles. 25,000 w. Revue de Mécanique—Feb., Apr., May, 1897. No. 17887, each H.

Circulation.

A Contribution to the Study of the Circulation of Water in Steam Boilers. (Contribution à l'Etude de la Circulation de l'Eau dans les Chaudières.) Ch. Bellens. A review of the theory of M. Brillié, criticising the latter's application of principles of hydrostatics to problems in hydrodynamics, and offering a new theory to account for the phenomena described in his experiments. Serial. Part I. 2500 w. La Revue Technique—Jan. 10, 1898. No. 17825 D.

Coal Ash.

See Mining & Metallurgy, Coal and Coke.

Furnace.

See Mining and Metallurgy, Miscellany.

Mechanical Draft.

Influence of Mechanical Draft on Ultimate Efficiency of Steam Boilers. Extract from a work prepared by Walter B. Snow, and published by the B. F. Sturtevant Co., of Boston. Considers the influence from a commercial standpoint, as measured by its aggregate first cost, and the consequent fixed charges thereon. 2000 w. Ir Age—Jan. 27, 1898. No. 18040.

Stay-Bolts.

Concerning Stay-Bolts. A discussion of means of detecting broken stay-bolts, and the cause of the breakage. 1800 w. Locomotive—Dec., 1897. No. 17703.

Steam Raising.

Steam Raising by Water-Tube Boilers. Harold W. Kolle. Read before the Gloucestershire Engineering Society. States the requirements of a perfect steam boiler, briefly considers bent-tube and straight-tube boilers, and how far they fulfill these requirements, and the advantages of the water-tube over the shell construction. 2200 w. Col Guard—Jan. 14, 1898. No. 17996 A.

COMPRESSED AIR.

Air Motors.

The Hoadley-Knight Compressed Air Motors Describes and illustrates this type of car, giving details of construction. 2300 w. R R Gaz—Dec. 31, 1897. No. 17487.

Explosions.

Compressed Air Explosions. Frank Richards. Refers to the discussion of Mr. Dickie's paper before the A. S. M. E. and considers any reference to the fact that fatal explosions of vaporized oil have occurred with air compressors as unnecessary. 900 w. Am Mach—Dec. 30, 1897. No. 17474.

Compressed Air Explosions. William E. Gibbs. A letter to the editor giving an experience of the writer, where an explosion was in his opinion caused by the ignition of oil vapor or spray mixed with air. 1200 w. Am Mach—Jan. 13, 1898. No. 17729.

Explosions of Air Compressors. Translated and condensed from *Gluckaüf.* Investigations made by the L. A. Riedinger Machine Co., of Augsburg, Germany. 900 w. Am Mach—Jan. 27, 1898. No. 18058.

Iron Cleaning.

Opinions on the Sand-Blast for Cleaning Structural Iron. Reports that the consensus of replies from about twenty prominent engineers is that the use of the sand-blast for this purpose is wise and judicious. Based on work on the 155th St. Viaduct in New York. 800 w. Eng News—Jan. 13, 1898. No. 17715.

Pneumatic Tools.

Improved Pneumatic Tools for Foundry Use. George H. Robbins. Read at meeting of Foundrymen's Assn., Philadelphia. Mentions defects in the old style of tools, faults in operating, the amount of work, &c. 1800 w. Ir Age—Jan. 13, 1898. No. 17719.

The Harthan Pneumatic Tool. Describes a chipping tool, or a combined hammer and chisel. Ill. 1000 w. Am Mach—Jan. 13, 1898. No. 17727.

Pneumatic Tubes.

The Batcheller System of Pneumatic Tubes. Illustrations showing the main features of the mail service between the main Post-Office and the Produce Exchange office of New York. 1700 w. Am Mach—Jan. 25, 1898. No. 17952.

ENGINES AND MOTORS.

Automobile Motor.

Roots and Venables Oil-Motors and Mechanism for Vehicles. An illustrated description of the latest model of this firm. It is intended for road vehicles and embodies their most recent improvements. 1600 w. Automotor Jour—Jan., 1898. No. 18065 A.

Balanced Valves.

Note on Balanced Slide Valves. (Note sur les Tiroirs Equilibrés.) M. Troisier. Devoted especially to the valves used on the locomotives of the Eastern Railway of France, and also describing other systems used in England and the United States. Gives methods of computing the proper area to be relieved of pressure. 5000 w. Revue de Mécanique—Feb., 1898. No. 17886 H.

Blowing Engines.

Valves for Blowing Engines. (Ueber Gebläseventile) H. Hörbiger. Illustrating and describing improved forms of annular air valves for blast furnace blowing engines. 3000 w. Stahl und Eisen—Jan. 1, 1898. No. 17855 D.

Compression.

Experiments on the Compression of Steam in the Clearance Space. (Expériences sur la compression de la Vapeur dans l'Espace Mort.) M. Dwelshauvers-Dery. A very important paper showing the causes for the inability of compression to prevent the losses due to excessive clearance. 8000 w. Revue de Mécanique—Oct., 1897. No. 17897 H.

Experiments on the Compression of Steam in the Clearance Space. M. Dwelshauvers-Dery. Translated from the Revue de Mécanique. A full translation of Prof. Dery's important paper. 3000 w. Power—Jan., 1898. Serial. 1st part. No. 17626.

Current Motor.

Floating Dam for the Production of Electric Energy. (Ein Schwimmendes Durchlauf-Wehr als Erzeuger Elektrischer Energie.) An illustrated account of the von der Heydt current motor system, with turbines on horizontal axes, placed in a pontoon dam. 3500 w. Der Elektro-Techniker—Dec. 15, 1897. No. 17878 B.

The Utilization of Running Streams. (Utilisation des Eaux Courantes.) The von der Heydt current motor consists of a pontoon dam containing turbines and electric generators, and which may be swung aside readily in order to afford a clear waterway. 2500 w. La Revue Technique—Dec. 25, 1897. No. 17821 D.

Deep-Well Pump.

A New Continuous Flow Deep-Well Pump. E. E. Johnson. Describes briefly the direct-acting steam deep-well pump and the air-lift pump as the two methods now in use, and gives illustrated description of a new continuous-flow deep-well pump, tests of actual plants, &c. 1500 w. Eng News—Jan. 20, 1898. No. 17942.

Engine Construction.

Steam Engine Construction and its Relation to Electrotechnics. (Der Dampfmaschinenbau und Seine Beziehungen zur Elektrotechnik.) A paper by Prof. Gutermuth, of Dresden, discussing the special influence which the development of electric stations has had upon the construction and design of steam engines. 6000 w. Zeitschr d Ver Deutscher Ing—Dec. 11, 1897. No. 17801 D.

Engine Tests.

Determination of the Fundamental Data of a Steam Engine Test. (Detérmination des Données Fondamentales dans un Essai de Machine à Vapeur.) M. Dwelshauvers-Dery. Giving instructions as to the application of Hirn's analysis to a steam engine test, including all the necessary data for the computation of the heat exchanges. An important contribution to the science of steam engineering. Three articles, 22000 w. Revue de Mécanique—Jan., Mar., May, 1897. No. 17881, each H.

Gas Engines.

Gas and Petroleum Motors. (Les Moteurs à Gaz et à Pétrole.) G. Richard. A very fully illustrated series of descriptive articles covering the entire field of internal combustion motors as at present constructed in Europe and America. Three articles. 15000 w. Revue de Mécanique—Jan., Mar., May, 1897. No. 17885, each H.

On the Utilization of Blast Furnace Gases by Means of the Gas Engine. William Galbraith. Results of the working at Wishaw, Scotland. 2700 w. Prac Eng—Jan. 7, 1898. No. 17908 A.

The Economy and Efficiency of the Large Gas Engine. Dugald Clerk. Discussing the leading problems now awaiting solution before larger engines can be commercially successful; also, reference to improvements desired in producers for power gas. 2500 w. Engineering Magazine—February, 1898. No. 18077 B.

The Gas Engine and Its Mission. Sidney A. Reeve. Part first gives a brief historical review and discusses the general arrangement and methods of governing and of ignition, types of valves and color of paint. 4000 w. R R Gaz—Jan. 7, 1898. Serial. 1st part. No. 17561.

Hydraulic Engine.

An Hydraulic Engine. Arthur Rigg. Reviews various makes of hydraulic engines, and notes the wasteful manner in which the pressure water is applied, when operating under partial loads, and gives illustrated description of invention of the writer. 3000 w. Engr, Lond—Jan. 14, 1898. No. 17989 A.

Hydraulic Plant.

See Electrical Engineering, Power.

Mill Engine.

1600 Indicated Horse-Power Triple-Expansion Mill Engine. Illustrated description of engine made by Messrs. Cole, Marchent and Morley (England). 1500 w. Engr, Lond—Jan. 14, 1898. No. 17990 A.

Rotary Engine.

Hult's Rotary Engine. Illustrated detailed description of an engine awarded a gold medal at the recent Stockholm Exhibition. 1200 w. Engng—Dec. 24, 1897. No. 17606 A.

Steam Engine.

A Patent Steam Engine. I. A. Ferrari. An explanation, from a theoretical point of view, on the efficiency of a patent steam-engine, as an improved means for producing a rotary from a reciprocating motion. Ill. 1100 w. Prac Eng—Jan. 7, 1898. No. 17907 A.

The Condensation of Steam in Steam Engines and its Measurement. A summary of the investigations reported in paper of H. L. Callendar and J. T. Nicolson, read before the British Assn. with comments. 3500 w. Engr, Lond—Dec. 31, 1897. Serial. 1st part. No. 17693 A.

The Steam Engine in the United States. (La Machine à Vapeur aux Etats-Unis.) R. H. Thurston. A general account of modern steam engine practice in the United States, followed by a description of the construction of the experimental engines at Cornell University, and accounts of tests made upon them. Four articles. 16000 w. Revue de Mécanique—May, July, Sept., Nov., 1897. No. 17892, each H.

Superheated Steam.

Engines for Superheated Steam. (Ueber Heissdampfmaschinen.) A. Seemann. With a full account of the remarkable performances of the Schmidt superheated steam engine, which used only 9.8 lbs. of steam per h. p. hour. Three articles. 12000 w. Zeitschr d Ver Deutscher Ing—Dec. 11, 18, 25, 1897. No. 17800 H.

The Application of Superheating to Steam Engines. (Application de la Surchauffe aux Machines à Vapeur.) F. Sinigaglia. A fundamental investigation of superheating from a theoretical and practical point of view, with many descriptions of apparatus and reports of tests. Six articles. 20,000 w. Revue de Mécanique—Mar., Apr., June, Aug., Oct., Dec., 1897. No. 17891, each H.

Turbines.

Low Pressure Turbines with Increased Rotative Speed. (Ueber Niederdruckturbinen mit Gesteigerter Umdrehungszahl.) Prof. R. Escher. A mathematical discussion showing that by modifying the bucket curves a higher rotative speed can be obtained than usual with low heads, thus enabling direct connection to be made with electric generators. 1800 w. Schweizerische Bauzeitung—Jan. 8, 1898. No. 17840 B.

POWER AND TRANSMISSION.

Aerial Railway.

Aërial Railway in Colombia. Translated copy of the contract for the construction of an aërial railway between the city of Honda and Argualarga or its suburbs. 1600 w. Cons Repts—Jan., 1898. No. 17735 D.

Belts.

Selection, Handling and Care of Belts. Charles H. Garlick. Some advice on this subject, giving serviceable rules for obtaining width, length, &c., and discussing the value of rubber and leather belts, and matters relating to the adjustment. 1800 w. Min & Sci Pr—Jan. 22, 1898. No. 18054.

Hoisting.

Hoisting Machinery. (Les Appareils de Levage.) Including jacks, chain blocks, link belt elevators, conveyors, &c. Three articles. 12000 w. Revue de Mécanique—Feb., Apr., Aug., 1897. No. 17890, each H.

Pulleys.

The American All Wrought-Steel Pulley. Illustrated detailed description of how it is manufactured. 2500 w. Ir Age—Jan. 6, 1898. No. 17576.

Transmission.

See Mining and Metallurgy, Mining.

SHOP AND FOUNDRY.

Annealing.

The Annealing of Cast Iron. George C. Davis. Read at meeting of Foundrymen's Assn., Philadelphia. Reviews the opinions of various writers and gives conclusions from the writer's experience. 1600 w. Ir Age—Jan. 13, 1898. No. 17718.

Casting.

Casting a Fly-Wheel. R. Brief description of the plant of the Sessions Foundry Co., of Bristol, Conn., with account of the casting of a big fly-wheel. Ill. 2300 w. Am Mach—Jan. 13, 1898. No. 17725.

Clean Iron Castings. Walter J. May. General discussion of the subject, noting the difficulties, faults, &c., and means of overcoming them. Gives test results where one of the new forms of ferro-sodium is used, showing how this flux affects iron. Considers a good flux a desirable thing. 1700 w. Col Guard—Jan. 7, 1898. No. 17790 A.

Crane.

Electrically Driven Cranes. (Elektrisch Betriebene Krane.) C. Eberle. The first of a series upon electric cranes built in Germany. This article contains description of a single-motor travelling crane by Collet and Engelhard, and a travelling jib crane by Scholten. Serial. Part I. 4500 w. 1 plate. Zeitschr d Ver Deutscher Ing—Jan. 1, 1898. No. 17805 D.

Dividers.

Divider Points for Vernier Calipers. Describes an attachment designed by the writer, which will not interfere with other uses of the caliper, and will give the added advantages of an accurately graduated scale and fine screw or vernier adjustment. Ill. 2300 w. Am Mach—Dec. 30, 1897. No. 17475.

Electric Driving.

See Electrical Engineering, Power.

Electrical Machinery.

See Electrical Engineering, Power.

Etchings.

Shop Etchings. J. A. Carney. Read before the St. Louis Ry. Club. Short accounts of the methods of manufacture of iron and steel are given, the process of etching described and its use. Ill. 1800 w. Ir Age—Jan. 20, 1898. No. 17941.

Gates.

Molders' Gates. R. D. Moore. Hints concerning the shaping of gates. Ill. 700 w. Am Mach—Jan. 13, 1898. No. 17728.

Gearing.

The Generation of Gear-Tooth Outlines. (Das Erzeugung der Zahnformen für Räder.) Hermann Fischer. A general review of the various mechanical methods of generating the shapes of teeth for spur and bevel gearing directly in the gear-cutting machines. 4000 w. Zeitschr d Ver Deutscher Ing—Jan. 1, 1898. No. 17806 D.

Hydraulic System.

See Mining and Metallurgy, Mining.

Lathes.

Lathe and Shaper Work. A. H. Cleaves. Illustrated description of methods of doing work. 1500 w. Am Mach—Dec. 30, 1897. No. 17476.

Slotting in the Lathe. John Randol. Describes a rather unusual piece of shop work. 1000 w. Am Mach—Jan. 20, 1898. No. 17953.

Lifts and Cranes.

See Electrical Engineering, Power.

Lubrication.

A Study of Lubrication. (Etude sur le Graissage.) E. Maglin. Discussing the chemical and physical laws of lubrication, with illustrated descriptions of a variety of devices for testing lubricants. Two articles. 8000 w. Revue de Mécanique—July, Oct., 1897. No. 17895, each H.

Metalloids.

The Value of Metalloids in Cast Iron. Malcolm McDowell. Read at meeting of the Western Foundrymen's Assn., Chicago. Showing the advantage of buying and selling pig iron by analysis. Also discussion. 4000 w. Ir Age—Jan. 27, 1898. No. 18041.

Milling.

Milling Spirals in the Lathe.—Tools for Grooving Cams in the Drill Press. A. H. Cleaves. Illustrated description of practices of value. 1500 w. Am Mach—Jan. 27, 1898. No. 18057.

Molding.

Molding Columns in the Floor. L. C. Jewett. Gives a sketch of a column and the rigging used to mold it, with description of process. 700 w. Am Mach—Jan. 6, 1898. No. 17567.

Ordnance.

The Construction of Modern Wire-Wound Ordnance. Part first describes the preparation of the wire used. 3000 w. Engr, Lond—Jan. 7, 1898. Serial. 1st part. No. 17797 A.

Pulleys.

See Mechanical Engineering, Power and Transmission.

Pumps.

Pumping Machinery. (Les Pompes.) M. Masse. A comprehensive essay, beginning with the hydraulic ram, and including hand and steam pumps, both vertical and horizontal, with a mathematical analysis of the discharge from a number of connected pumps. Five articles. 28000 w. Revue de Mécanique—Feb., Mar., June, Sept., Nov.,1897. No. 17888, each H.

Pumps—Inside Connected and Inside Packed, Walter Ferris. Favoring outside packed pumps. Ill. 1600 w. Am Mach—Jan. 6, 1898. No. 17566.

Pumping Engine.

See Mining and Metallurgy, Mining.

Riveted Joints.

Experiments on the Frictional Resistance of Riveted Joints. Schröder van der Kolk. A paper before the Royal Institution of Engineers of Holland, translated from the *Zeitschrift des Vereines deutscher Ingenieure*. Gives conclusions from careful experiments made to determine the degree of influence exerted by frictional resistance on the strength and general efficiency, with particular reference to railway-bridge design. 800 w. Prac Eng—Jan. 14, 1898. No. 18069 A.

Screw Dies.

The Hartness System of Screw Dies. An illustrated description of die head, including a brief account of the method of making the chasers. 1700 w. Am Mach—Jan. 6, 1898. No. 17568.

Shop Suggestions.

Shop Talks with the Young Mechanics. W. H. Van Dervoort. The first of a series of talks aiming to present some points relating to tools and their correct and efficient use. Part first deals with the hammer and cold chisel. Ill. 1800 w. Mach, N. Y.—Jan., 1898. Serial. 1st part. No. 17629.

Shop Work.

An Example of Shop Work. A. L. G. Illustrated description of how a number of special interchangeable spindles were made. 1200 w. Mach, N. Y.—Jan., 1898. No. 17628.

Tools.

Machine Tools. (Les Machines-Outils.) G. Richard. Elaborately illustrated articles upon improvements in machine tools since 1895 ; especially devoted to American lathes and milling machinery. Four articles. 28000 w. Revue de Mécanique—Feb., Apr., June, Oct., 1897. No. 17889, each H.

Turbines.

Machines of the Turbine Class (Les Turbo-Machines.) A. Rateau. A series of articles on the various machines of the turbine class, including hydraulic and steam turbines, fans, centrifugal pumps, and screw propellers. The two articles thus far published are devoted to the mathematical principles involved. Two articles. 12000 w. Revue de Mécanique—July, Sept., 1897. No. 17894, each H.

Worm Gearing.

Modern Practice with Worm Gearing. F. A. Halsey. A presentation of the general conditions of successful practice as in use at present. Prof. Barr's theory of worm efficiency is examined and the most efficient thread angles are given, based largely upon the experiments of Wilfred Lewis. 2000 w. Am Mach—Jan. 13, 1898. No. 17726.

MISCELLANY.

Animal Power.

Comparison of the Thermal or Dynamical Power of Simple Elements with their Nutritive Power. (Comparaison du Pouvoir Thermogène ou Dynamogène des Eléments Simples avec leur Pouvoir Nutritif.) A. Chauveau. An investigation into the possible cause of the high efficiency of animal power based on the food consumed. A valuable investigation of the nature of animal power. 4500 w. Comptes Rendus—Dec. 20, 1897. No. 17828 D.

Artillery.

Artillery Construction. (Le Matériel d'Artillerie.) Colonel X. Discussing and illustrating the latest improvements in breech-closing devices, both wedge and screw ; also rapid fire guns and carriages for field pieces with improved cushioning devices. Five articles. 30,000 w. Revue de Mècanique—June, July, Sept., Oct., Dec., 1897. No. 17893, each H.

Automobiles.

Post-Office Motor Vans. An account of the trials made in England with self-propelled vehicles for carrying mails. 500 w. Engr, Lond—Dec. 24, 1897. No. 17595 A.

Report on Motor Vehicles in France. (Bericht über die Motorwagen in Frankreich.) A translation of the report on the recent " heavy-weight " competitions of automobiles in France. Serial. Part I. 7500 w. Glaser's Annalen—Jan. 1, 1898. No. 17814 D.

Automobile Motor.

See Mechanical Engineering, Motors.

Bicycles.

Conclusions Deduced from Efficiency Tests of Bicycles. R. C. Carpenter. Explains the meaning of "efficiency" as here used, gives various tests which show little loss of power in the ball bearings, great loss in the tire, and considerable in the gearing. 2400 w. Sib Jour of Engng—Jan., 1898. No. 18016 C.

Bicycle Tires.

Progress in the Weaving of Bicycle-Tire Fabrics. From *The Cycle Age* (Chicago). Reviews the history of pneumatic tires, the difficulties encountered and the extent to which they have been overcome. 2000 w. Ind Rub Wld—Jan. 10, 1898. No. 17966 D

Creusot Works.

See Mining and Metallurgy, Iron and Steel.

Elevators.

Hydraulic or Electric Elevators. William H., Bryan. Extracts from a report submitted to owners of a St. Louis building, stating the advantages of each. 1600 w. Eng Rec—Jan. 1, 1898. No. 17507.

Entropy.

The Entropy Diagram and its Applications. (Le Diagramme Entropique et ses Applications.) Prof. J. Boulvin. A very lucid and thorough treatise on the principles of thermodynamics, with practical applications of the entropy diagram to steam and gas engines as well as refrigerating machinery. Four articles. 26000 w.

Revue de Mécanique—Jan., Feb., Apr., June, 1897. No. 17882, each H.

Flat Surfaces.

The Theory of Flat Heads. (La Théorie des Fonds Plats.) C. Walckenaer. A very full discussion of the experiments of Prof. Bach of Stuttgart upon the strength of flat heads of cylindrical vessels subjected to internal pressure. 12000 w. Revue de Mécanique—Dec., 1897. No. 17899 H.

Gutta Percha.

See Electrical Engineering. Miscellany.

Levels.

A Level of Ye Olden Time. Otto von Geldern. Historical review of the earliest contrivances for this use, and a memoir published with the papers of the Royal Acad. of Paris for the year 1704, by M. de la Hire, describing a level on the principle of fastening an iron rule at its center of gravity to an upright support canting on its base. Discussion. 7500 w. Jour Assn of Engng Soc—Dec., 1897. No. 17976 C.

Mechanics.

Mechanical Engineering. Editorial review from the English standpoint, dealing with motor cars, railroading, refrigerating machinery, &c. 7000 w. Engr, Lond—Jan. 7, 1898. No. 17901 A.

Moisture.

Determining the Moisture in Steam Pipes. D. S. Jacobus. Abstract from a paper in *The Stevens Indicator*. Describes a method which has given reliable data, pointing out the advantages over other methods. 1300 w. Eng News —Jan. 27, 1898. No. 18030.

Motion.

Note on the Propagation of Motion. (Sur la Vitesse de Propagation d'un Mouvement.) P. Vieille. An investigation of the velocity of propagation of a movement in a medium which is at rest showing experimentally that the velocity is that of sound in the same medium. 1500 w. Comptes Rendus—Jan. 3, 1898. No. 17833 D.

See also Electrical Engineering, Miscellany.

Range Finder.

The Weldon Range Finder, Its Use and Its Theory. Alston Hamilton and H. L. Hawthorne. On the value of this range finder, and the uses to which it may be applied. 4000 w. Jour U. S. Artillery—Nov-Dec., 1897. No. 17738 D.

Refrigeration.

Refrigerating Machinery. (Les Machines Frigorifiques.) G. Richard. Describing the various machines introduced since 1889, with accounts of their applications, records of tests, and determination of data for subsequent use in designing refrigerating apparatus and investigating the theory of these machines. Four articles, with many illustrations. 20000 w. Revue de Mécanique—Jan., Mar., May, Sept., 1897. No. 17884, each H.

Roller Bearings.

Mr. W. Hugh Woodcock on Roller Bearings. Excerpt from a paper read before the Liverpool Section of the Self-Propelled Traffic Assn. Discusses the requirements of a satisfactory roller bearing, and reports tests. 4000 w. Automotor Jour—Jan., 1898. No. 18066 A.

See also Railroad Affairs, Maintenance of Equipment.

Screw Threads.

Rules for the Construction of Machine Screw Threads. (Règles pour la Construction des Vis Mécaniques.) E. Sauvage. Discussing the new metric screw thread system adopted by the *Société d'Encouragement pour l'Industrie Nationale*, and also the standard wire gauge of the same society. With graphical scale of screw proportions and a comparison with English and American threads. 4000 w. Revue de Mécanique—May 1897. No. 17770 H.

Stack.

The Raising of a 150-Stack in One Piece. Describes the raising of a stack at Haysville, near Pittsburg, at the works of the Sterling Varnish Co. Ill. 1200 w. Am Mfr & Ir Wld —Jan. 21, 1898. No. 17983.

Strength Recorder.

A Spring Ergograph. (Sur un Ergographe à Ressort.) MM. Binet and Vaschide. An improved apparatus for recording physical efforts, so arranged as to register the maximum strength of the subject. 1000 w. Comptes Rendus—Dec. 27, 1897. No. 17829 D.

Testing.

Determination of the Elasticity of the Same Specimen under Tension and Compression. (Ermittlung der Zug-und Druckelastizität an dem gleichen Versuchskörper.) C. Bach. The improved indicators for showing the variations in length of a test specimen enable accurate measurements to be made both under tensile and compressive stresses. Photographs of the apparatus in use are given, together with data of a series of tests on cast iron. 4000 w. Zeitschr d Ver Deutscher Ing—Jan. 8, 1898. No. 17808 D.

Testing Machine.

A Photographic Impact Testing Machine for Measuring the Varying Intensity of an Impulsive Force. B. W. Dunn. Discussion of this paper. 4300 w. Jour Fr Inst—Jan., 1898. No. 17649 D.

Traction.

Mechanical Traction. (La Traction Mécanique.) A. Barbet. The introductory article of a series, treating in a general way of the use of common roads for motor vehicles and to be followed by a discussion of the various improvements in mechanical traction. 5000 w. Revue de Mécanique—Nov., 1897. No. 17898 H.

Wire Nails.

The Shearing Strength of Wire Nails. A thesis by Frank Bates Walker and Charles H. Cross, University of Minnesota. Statement of experiments made by the writers with tabulated results. Also discussion. Ill. 3800 w. Jour Assn of Engng Socs—Dec., 1897. No. 17977 C.

MINING AND METALLURGY.

COAL AND COKE.

Belgium.

Coal Mining in the Liège District of Belgium. From a Foreign Office report by Vice-Consul Menzies. 1200 w. Col Guard—Dec. 24, 1897. No. 17603 A.

Coal and Iron.

The Foreign Coal and Iron Trades in 1897. Review of these industries in Germany, France, Sweden, Belgium, Russia and Austria. 6500 w. Ir & Coal Trds Rev—Dec. 31, 1897. No. 17668 A.

Coal Ash.

Relation between the Composition of Coal Ash and its Fusibility. (Relation entre la Composition des Cendres de Houille et leur Fusibilité.) A notice of the investigations of M. Eugène Prost, showing that the fusibility of an ash depends upon the relation between the lime, magnesia and oxid of iron on one part, and the silica and alumina on the other. 1500 w. Moniteur Industriel—Dec. 11, 1897. No. 17836 G.

Coal Bed.

The Pittsburg Coal Bed. I. C. White. A consideration of the age, structure, area, importance and value. 4000 w. Am Geol—Jan., 1898. No. 17667 D.

Coal-Cutter.

The Schaub Electrical Coal-Cutter. V. Waltl, *Oesterreichische Zeitschrift für Berg-und Huttenwesen.* Illustrated description of a machine presenting many interesting points, being tried at the Piberstein Brown-Coal Colliery in Austria. 1800 w. Col Guard—Jan. 7, 1898. No. 17791 A.

Coal Storage.

Coal Storage Plant of the Tamarack Mining Co., Dollar Bay, Mich. Illustrated description of the principal structural features of this plant. 1000 w. Eng News—Dec. 30, 1897. No. 17478.

Coal Trade.

The Coal Trade in 1897. Reviews the English trade of the year in Northumberland, Durham, Lancashire, Yorkshire, &c., also the business in Scotland and London. 8500 w. Col Guard—Jan. 7, 1898. No. 17788 A.

Coke.

Concerning Sulphur in Coke. (Ueber den Schwefelgehalt des Koks.) Giving analyses of cokes from various parts of Europe, and discussing the effect of the presence of sulphur upon the iron smelted with such fuel. 2500 w. Stahl und Eisen—Jan. 1, 1898. No. 17854 D.

Coke Oven.

The Collin Coke Oven. Notes the particular features and describes how the ovens are used. Ill. 1600 w. Col Guard—Jan. 7, 1898. No. 17789 A.

Explosions.

Explosions in Coal Mines. John Hayes. Part first considers the gases exuded in coal-mines and those causing explosions, giving examples, with review of experiments recorded. 3000 w. N Zeal Mines Rec—Dec. 16, 1897. Serial. 1st part. No. 17917 B.

Explosives.

New Order as to the Use of Explosives in Coal Mines. A new order, dated Dec. 20, 1897, repealing all previous orders, and based on list of explosives which have passed the official test at the Royal Arsenal, Woolwich, Eng. 4000 w. Col Guard—Dec. 24, 1897. No. 17602 A.

The Testing of Explosives for Use in Coal Mines. Report of the English Departmental Committee appointed to inquire into the best tests to determine the safety. 3400 w. Col Guard—Dec. 24, 1897. No. 17600 A.

Formation.

The Formation of Coal. H. F. Bulman. From *Journal of the British Society of Mining Students.* Brief consideration of theories advanced. 1200 w. Col Guard—Jan. 14, 1898. No. 17994 A.

Mine Plant.

Coal Mine Plant at Diamondville, Wyo. W. P. Hardesty. Brief description of a substantial plant recently built. 700 w. Eng News—Dec. 30, 1897. No. 17479.

Ohio Coal.

The Geology of the Jackson Shaft Coal. Andrew Roy. Read at meeting of Ohio Inst. of Mining Engs. Describes this peculiar deposit in Southern Ohio. 1800 w. Am Mfr & Ir Wld—Jan. 21, 1898. No. 17984.

Peat.

Coking Peat. Dr. Holtz, in *Zeitschrift für Angewandte Chemie.* Describes the Ziegler-Stiemer process of preparing the pressed peat; coking; and utilizing the products. 800 w. Col Guard—Jan. 7, 1898. No. 17796 A.

Portugal.

Buarco's Colliery, Cabo Mondego, Portugal. From a communication by M. Sylva Cattier to the Charleroi Committee of the Society of Hainaut Engineers. Information of the structure of the seam, quality of the coal, method of working, &c. 1200 w. Col Guard—Dec. 31, 1897. No. 17689 A.

GOLD AND SILVER.

Auriferous Beaches.

Auriferous Beaches on the West Coast. Mr. Macfarlane. These beaches contain gold in immense quantities, intimately associated with magnetite and other minerals. Gives conclusions reached as to the source of the gold, and to the probability of good returns from the working of these beaches. 2000 w. N Z Mines Rec—Nov. 16, 1897. No. 17583 B.

Australia.

Notes on Western Australia Mines. Jos. Gruss. Information of mining affairs from one recently returned from this region. 2700 w. Min & Sci Pr—Jan. 1, 1898. No. 17617.

British Columbia.

Boundary and Trail Creek Mining Districts of British Columbia. W. L. Austin. Describes the country, the geological formations, occurrence of the ores, their character and value, and the extent of their development. 6000 w. Mines & Min—Jan., 1898. No. 17758 C.

British Columbia Mines in 1897. William A. Carlyle. Reports the condition of the mining industry, and gives brief description of the principal mining districts. 1800 w. Eng & Min Jour—Jan. 8, 1898. No. 17630.

California.

California Mines in 1897. Reviews the improvements in connection with the mining industry, and the work generally. 1200 w. Eng & Min Jour—Jan. 8, 1898. No. 17633.

Colorado.

Colorado Past and Present. Reviews the condition forty, thirty, twenty and ten years ago, and gives the output of precious metals and review of the mining industry during the past year. 8500 w. Min Ind & Rev—Jan. 6, 1898. No. 17664.

Mining in Gilpin County, Colorado, in 1897. George E. Collins. Reviews the different districts showing a large increase over 1896. 2500 w. Eng & Min Jour—Jan. 15, 1898. No. 17773.

Mining in Lake County, Colorado, in 1897. A summary of the year's work and the operations of importance being conducted. 3600 w. Eng & Min Jour—Jan. 22, 1898. No. 17972.

Cripple Creek.

Cripple Creek, Colorado, Mines in 1897. Reviews the work of the past year, showing the outlook to be very favorable. 1200 w. Eng & Min Jour—Jan. 8, 1898. No. 17632.

Cyanid.

Influence of the Anodes in Depositing Gold from its Cyanid Solution. E. Andreoli. Refers to the important work in this field and the results, and gives the writer's experience with peroxidized lead anodes. 1500 w. Eng & Min Jour—Jan. 22, 1898. No. 17971.

Cyanogen.

The Solvent Powers of Cyanogen. William Skey. Condensed paper describing tests made and giving some facts ascertained. 900 w. Min & Sci Pr—Jan. 15, 1898. No. 17950.

Gold-Bearing Stones.

The Witwatersrand Banket, With Notes on Other Gold-Bearing Pudding Stones. George F. Becker. Part first is introductory, giving an outline of the geological position and the relations to the auriferous regions of Southern Africa. 800 w. Min & Sci Pr—Jan. 15, 1898. Serial. 1st part. No. 17951.

Goldfields.

The Geology and Veins of the Hauraki Goldfields. James Park. Read before the New Zealand Inst. of Mining Engs. Abstract of paper on one of the most interesting gold-bearing areas of New Zealand. 2800 w. N. Z. Mines Rec—Nov. 16, 1897. No. 17582 B.

Gold Mine.

A Great Gold Mine. John W. Gray. The story of Mount Morgan, Australia, is briefly told. 1800 w. Min & Sci Pr—Jan. 15, 1898. No. 17949.

Klondike.

The Klondike Gold Fields. Gives views of two prominent men who have spent some time in this region, and also comments on the preparations being made in Victoria for the coming trade. 1500 w. Cons Repts—Jan., 1898. No. 17496 D.

Milling.

Notes on Milling Gold-Bearing Ores. The importance of a knowledge of metallurgy for the profitable milling of gold, the occurrence, processes, &c. 2800 w. Min Ind & Rev—Jan. 13, 1898. No. 17932.

Montana.

Montana Mines in 1897. Shows that the adoption of the single gold standand has been one cause of the renewed activity in placer mining and gives a brief summary of the principal mines. 1600 w. Eng & Min Jour—Jan. 8, 1898. No. 17636.

New South Wales.

The Wolumla Goldfield. J. E. Carne. Report on the geology and auriferous resources of this gold field in the southern district of New South Wales. 2800 w. Aust Min Stand—Dec. 16, 1897. Serial. 1st part. No. 17923 B.

Peru.

Gold Mines of Peru. Report on the gold district of Carabaya, Peru, by the late civil engineer, E. J. Prew. 1700 w. Cons Repts—Jan., 1898. No. 17737 D.

Prospecting.

Magnetic Methods of Prospecting in Sweden. From a report on the mining industry in Sweden, 1897, by Prof. Nordenström, of the Stockholm School of Mines. The instruments described have been utilized in all the mining districts and yielded valuable results, not only for iron, but also zinc, copper, nickel, and cobalt when mingled with magnetic minerals. 2400 w. Col Guard—Dec. 24, 1897. No. 17601 A.

Reef Disturbance.

Reef Disturbance in Westralia. Paper recently read by Mr. Horsley, before the Mine Managers Inst. of W. A. Discusses the causes and effects of the disturbance of reefs from the decomposition of rocks. 1600 w. Aust Min Stand—Dec. 9, 1897. No. 17920 B.

Separation.

The Separation of Gold and Silver in the Mint. Howard Lee Davis. Describes the nitric-acid, and the sulphuric-acid methods. 2300 w. Yale Sci M—Dec., 1897. No. 17544 C.

Testing.

Laboratory Testing of Ores for Concentration and Amalgamation. H. Van F. Furman. Information relating to how laboratory tests should be made, and the importance of making them before a mill-run is made. 2000 w. Min Ind & Rev—Jan. 13, 1898. No. 17933.

Victoria.

A Victorian Auriferous Zone. Ernest Lidgey. Gives facts relating to the reefs of the western portion of Victoria, with detailed information. 2400 w. Aust Min Stand—Dec. 16, 1897. No. 17922 B.

Washington.

The Deu Pree Lode, Washington. Henry Landes. Some account of mining development in the Cascade Mountains, with description of the property named. 2000 w. Eng & Min Jour—Jan. 8, 1898. No. 17631.

Witwatersrand.

The Gold Mines of the Witwatersrand, South Africa. John Hays Hammond. The first of an important series of papers upon the development of the gold mines of the Transvaal. This paper deals with the rapid development of the region and with its geological features, including the several theories as to the origin of the formations. 4000 w. Engineering Magazine—February, 1898. No. 18075 B.

Yukon.

Geology of the Yukon. Condensed from advanced sheets of work by Josiah Edward Spurr. Describes the rocks and the disturbances they have undergone, in part first. Min & Sci Pr—Jan. 22, 1898. No. 18055.

IRON AND STEEL.

Creusot Works.

Messrs. Schneider and Co.'s Works, Creusôt. Historical and descriptive. Ill. 2000 w. Engng—Jan. 7, 1898. Serial. 1st part. No. 17784 A.

Granulated Slag.

Brick Manufacture from Granulated Blast Furnace Slag. Condensed translation of article by F. W. Luermann, in *Stahl und Eisen*. Information relating to the manufacture and testing of these bricks. 900 w. Am Mfr & Ir Wld—Jan. 14, 1898. No. 17761.

Iron Industry.

The Iron Industry of the United Kingdom. Leonard H. Courtney. The second part of a presidential address on "Jevons' Coal Question: Thirty Years After," delivered before the Royal Statistical Society. 2300 w. Col Guard—Dec. 24, 1897. No. 17599 A.

Iron Mines.

The Iron Mines of Minnesota in 1897. Reports a larger production than ever before with information regarding labor, transportation, &c. 1500 w. Eng & Min Jour—Jan. 8, 1898. No. 17635.

Iron Ore.

The Outcrop of the Oolitic Iron Ore in the Southern Part of German Lorraine. (Das Vorkommen des Oolithischen Eisenerzes in Südlichen Theile Deutsch-Lothringens.) Fr. Greven. A geological description, with large colored map and sections of the locality. 6000 w. 2 plates. Stahl und Eisen—Jan. 1, 1898. No. 17852 D.

Steel Analysis.

Bibliography of the Metallography of Iron and Steel. Albert Ladd Colby. Prepared as an aid to those who wish to study the microscopic examination of these metals. 6000 w. Ir Age—Jan. 27, 1898. No. 18039.

Steel Making.

The Tropenas Steel-Making Process. The object of this invention is to obtain by pneumatic means, greater heat than is reached by the ordinary pneumatic process, and to secure a material of greater ductility. Illustrated description of the system is given, with report of tests. 2300 w. Engng—Jan. 14, 1898. No. 17998 A.

MINING.

Damages.

Delay in Seeking Remedy for Mining Damages. An explanation of English mining law on this subject. 3000 w. Col Guard—Dec. 24, 1897. No. 17598 A.

Economic Operation.

The Relation of the Mining Engineer to the Economic Operation of Coal Mines. S. A. Taylor. Read before the Central Mining Inst. of Western Pennsylvania, at Pittsburg. Showing how well it pays to employ an engineer to conduct the mining operations. 2000 w. Am Mfr & Ir Wld—Jan. 7, 1898. No. 17652.

Electric Driving.

See Electrical Engineering, Power.

Explosives.

Explosives for Use in Fiery Pits. J. von Lauer, in *Oesterreichische Zeitschrift für Berg- und Hüttenwesen*. Part first gives methods by means of which explosives may be employed with safety and economy. 1200 w. Col Guard—Jan. 14, 1898. Serial. 1st part. No. 17997 A.

Measures Adopted for Diminishing the Danger of Shot-Firing. Abstract from an official report by Bergassessor Dröge, Saarbrucken, published in the *Zeitschrift für das Berg-, Hütten, und Salinenwesen*. Gives particulars relating to the condition of the collieries, and the regulations in force as regards shot-firing. 3800 w. Col Guard—Jan. 14, 1898. Serial. 1st part. No. 17992 A.

The Use of Explosives in Gaseous Mines. (Sprengmittel mit Rücksicht auf ihre Verwendung in Schlagwetter führenden Gruben.) Joh. v. Lauer. A valuable paper discussing the action of blasting explosives in igniting firedamp, and giving the conditions under which they may be safely used. Two articles, 12,000 w. Oesterr Zeitschr f Berg-u Hüttenwesen—Dec. 18, 25, 1897. No. 17856 E.

Underground Magazines for Mine Explosives. From a report of the French Firedamp Commission by M. Ledoux. Regulations in different countries are given, with a summary of conclusions adopted in France, and discussion of the subject in general. 3500 w. Col Guard—Dec. 31, 1897. No. 17687 A.

Fans.

Experiments Upon Propeller Ventilating Fans, and Upon the Electric Motor Driving Them. William George Walker. Read before the

Institution of Mech. Engs., England. Part first notes former experiments, describes apparatus used, measurement of air discharge and of brake horse-power, &c. Ill. 3000 w. Prac Eng—Jan. 7, 1898. Serial. 1st part. No. 17909 A.

Notes on Mine Fans. William T. Clifford. Read at meeting of Western Pennsylvania Central Mining Inst., at Pittsburg. Traces the advances made in mine fans with consideration of some features. 1800 w. Am Mfr & Ir Wld—Jan. 7, 1898. No. 17653.

Firedamp.

Investigations as to the Ignition of Firedamp and Coal Dust by Electricity. (Versuche betreffend die Entzündlichkeit von Schlagwettergemischen und Kohlenstaubaufwirbelungen durch die Wirkungen der Elektrizität.) An account of the important experiments made at Gelsenkirchen by Herr Heise and Dr. Thiem. Serial. Part I. 4500 w. Glückauf—Jan. 1, 1898. No. 17850 B.

Haulage.

Electric Haulage for Mines. D. C. Thomas. Extract from a paper read at meeting of the Ohio Mining Inst. Points of importance are discussed and details given that will tend to bring satisfactory results. 1300 w. Ir Trd Rev—Jan. 27, 1898. No. 18056.

Hydraulic System.

The Brown Hydraulic System for Underground Pumping and Haulage. William F. Lang. Read before the Mining Inst. of Scotland. A description of the adaptation of this system to mining purposes. 1800 w. Col Guard—Dec. 31, 1897. No. 17686 A.

Lamp.

Accumulator-Maintained Miner's Lamp. M. G. Nicolai to the Liège section of the Assn. des Ingénieurs de Liège. Extract. Description and report of trials. 1300 w. Col Guard—Jan. 7, 1898. No. 17794 A.

Mexican Mine.

The Avino Mines. Auguste Mathez. An illustrated description of an old Mexican mine and the good and bad points of some of the ancient methods still in use. 2300 w. Mines & Min—Jan., 1898. No. 17753 C.

Mine Fire.

The Aspen Mine Fire. Arthur Lakes. The geology of Aspen and the conditions existing in the Smuggler mine at the time of the fire, some of the difficulties and the methods employed in extinguishing the fire, with report of the superintendent. Ill. 4000 w. Mines & Min—Jan., 1898. No. 17756 C.

Mining Law.

Covenants to Work Mines. Reviews decisions under English law upon this subject. 2800 w. Col Guard—Jan. 7, 1898. No. 17792 A.

Damages for Breaches of Contract in the Coal Trade. British law on this subject is shown by report of important cases. 2800 w. Col Guard—Dec. 31, 1897. No. 17685 A.

The Criminal Law Relating to Mines. An exposition of British law on this subject. 2400 w. Col Guard—Jan. 14, 1898. No. 17993 A.

Mining Stock.

The London Mining Stock Market in 1897. A brief description of the features of interest. 2000 w. Eng & Min Jour Jan. 8, 1898. No. 17637.

Pumping.

Electric Mine Pumping. F. C. Whitmore. Read before the Engineers' Club of Scranton, Pa. A comparison of the relative efficiencies of steam and electric pumps, with some reasons why electric pumps admit of greater economy than steam pumps. 2000 w. Mines & Min—Jan., 1898. No. 17755 C.

Pumping Engine.

A Duplex Hydraulic Pumping Engine. Stuart McMurtrie. From the *Journal of the British Society of Mining Students*. Describes the principle and working of a Hathorne Davey pumping-engine installed at Radstock. Ill. 1200 w. Col Guard—Jan. 7, 1898. No. 17793 A.

Respirator.

Respirators for Mining Work. (Ueber Athmungsapparate beim Bergbaubetriebe.) Johann Mayer. A general review of the various respirators for enabling exploration and relief to be done in gaseous or burning mines. The Neupert respirator, with oxygen reservoir and carbonic acid absorbent is illustrated. Serial. Part I. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 1, 1898, No. 17858 B.

Speaking Tubes.

Long-Distance Speaking Tubes in Mines. Schale, in *Zeitschrift für Berg-, Hütten-, und Salinen-Wesen*. Conclusions from results of experiments made to obtain material for guidance in setting up long-distance tubes and ascertaining the limits attainable for communication. 1000 w. Col Guard—Dec. 31, 1897. No. 17688 A.

Sweden.

Swedish Mining Work in 1897. (Schwedens Bergbaue im Jahre 1897.) A general review of the work of the past year, including iron, copper and zinc, as well as the other metals which occur in minor quantities. 2500 w. Oesterr Zeitschr f Berg-u Hüttenwesen—Dec. 18, 1897. No. 17857 B.

Transmission.

Transmission of Power by Ropes in Mines. G. D. Rice. Illustrated description of the main jack-wheel and connections designed for an installation operating five rope-drives from a tower. 800 w. Eng & Min Jour—Jan. 22, 1898. No. 17970.

Underground Work.

The Underground Work of the Samuelsglück Mine at Beuthen. (Unterwerksbau der Samuelsglück-Grube bei Beuthen.) An account of the extension of the underground work of a lead and zinc mine in Upper Silesia. Steam is conducted 2500 feet underground, to operate pumping and hoisting machinery. 1500 w. Zeitschr d ver Deutscher Ing—Jan. 1, 1898. No. 17807 D.

Ventilation.

Adequate Ventilation. E. W. Thirkell. Read before the Midland Inst. of Mining, Civil and Mechanical Engs. at Barnsley, March 27, 1897, and published in the Fed. Inst. of Mining Engs. The amount of air needed for men, horses and lights under various conditions, the effects of gases, methods of improving the ventilation and dangers from coal-dust. 3000 w. Mines & Min—Jan., 1898. No. 17754 C.

Hanarte's Contribution to the Study of Mine Ventilation. J. W. P. The substance of a preface called forth by the new edition of M. Haton de la Goupilliere's *Course of Mine Working*. 1500 w. Col Guard—Jan. 7, 1898. No. 17795 A.

MISCELLANY.

Aluminum.

The Impurities of Aluminum and its Alloys. (Sur les Impuretés de l'Aluminium et de ses Alliages.) P. Defacqz. A paper presented to the French Academy by M. Moissan ; the principal impurities found were iron and silica ; the methods of analysis are given. 1500 w. Comptes Rendus—Dec. 27, 1897. No. 17832 D.

Furnace.

Open Hearth Glass Furnaces. (Fours à Bassins pour Verriers à Vitre.) The Gobbe furnace, as used at the Jumel glass works in Belgium, gives much better results than pot melting. Producer gas is used and the homogeneous glass drawn from beneath the surface of the molten charge. A modification of the furnace is used for firing porcelain, &c. 3500 w. 1 plate. La Revue Technique—Jan. 10, 1898. No. 17827 D.

Kryolith.

Kryolith—Its Mining, Preparation and Utilization. William C. Henderson. An interesting account of this isolated deposit in Greenland, the methods of mining, process of producing soda, and other uses. 2500 w. Jour Fr Inst—Jan., 1898. No. 17650 D.

Metalloids.

See Mechanical Engineering, Shop & Foundry.

Metal Markets.

The London Metal Markets in 1897. Reviews the markets of copper, tin, spelter and antimony. 3500 w. Eng & Min Jour—Jan. 15, 1898. No. 17772.

Mica.

Mica-Mining in Bengal. Describes the region, the occurrence and methods of mining. 1500 w. Ind & East Engr—Dec., 1897. No. 17948 D.

Missouri.

The Ore Market of the Joplin, Missouri, District in 1897. Reports the condition of the zinc and lead industry. 1200 w. Eng & Min Jour—Jan. 8, 1898. No. 17634.

Peru.

A Rich Peruvian Mining Region. William Griffith. A geological description of the mineral resources in the neighborhood of Hualgayoc, Peru, with some account of the methods of mining, and the quaint village. 1700 w. Mines & Min—Jan., 1898. No. 17757 C.

Precious Stones.

Geography of Precious Stones. George F. Kunz. An interesting lecture considering the subject in several aspects. The famous gem regions, their influence on discovery and exploration, the building up of cities through this industry, commerce, &c. 4500 w. Jour Fr Inst—Jan., 1898. Serial. 1st part. No. 17648 D.

Review.

The Technical Literature of the Year. H. G. Graves. Review of the year's literature of the coal and iron industries, aiming to show the general trend thought has taken. 3000 w. Col Guard—Dec. 31, 1897. No. 17684 A.

School of Mines.

School of Mines for the Witwatersrand. John Daniell. Refers to some of the best-known schools of mines, and the systems of instruction adopted, making suggestions relating to this special field. 2800 w. Chem & Met Soc of S. Africa—Nov. 20, 1897. No. 17543 D.

Statistics.

The Mineral Statistics for 1897. The usual annual report published by this paper, containing full and valuable information of all the minerals and metals in the United States, and the production of gold in the whole world. 42000 w. Eng & Min Jour—Jan. 1, 1898. No. 17540.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Accounts.

Both Sides of the Ledger. Norton N. Humphrys. A consideration of the profits earned in the gas industry, and the means of ascertaining them. 2000 w. Jour Gas Lgt—Jan. 4, and 11, 1898. Serial. 2 parts. No. 17799 E.

Acetylene.

Acetylene from the Underwriters' Standpoint. E. B. Shuttleworth. Report submitted as the result of study of the manufacture and use of acetylene. Considers manufacture, storage and carriage of calcium carbid ; manufacture of acetylene at low pressure ; use of low pressure acetylene for illuminating purposes ; use of compresses or liquefied acetylene for illuminating purposes. 5000 w. Can Eng—Jan., 1898. No. 17760.

Explosion of an Acetylene-Gas Plant in the Post Office Building, Wilmington, Del. W. A. Jones. Describes the plant and gives facts gathered, and inferences as to its cause. Ill. 1700 w. Eng Rec—Jan. 15, 1898. No. 17766.

Regulations for Acetylene Lighting at Berlin. Translated from the "*Zeitschrift für Beleuchtungswesen.* Regulations relative to the production and use, for employers, and workmen in other than large works. 1500 w. Pro Age—Jan. 1, 1898. No. 17502.

The Technical Analysis of Calcium Carbid and Acetylene and the Purifying of the Latter. G. Lunge and Edward Cedercreutz. Gives method proposed by the authors to determine, analytically, the possible 4% of impurities in acetylene. 1800 w. Gas Wld—Jan. 1, 1898. No. 17674 A.

Composimeter.

Principle of the Gas Composimeter. Edward A. Uehling. Illustrated description of apparatus, and explanation of principle. 1800 w. Gas Wld—Jan. 15, 1898. No. 18004 A.

Distribution.

Facts versus Logic in the Distribution of Gas. J. P. Gill. Criticism of a contribution by D. Coats Niven to the *Journal of Gas Lighting*, in reference to "the Distribution of Gas." 1200 w. Am Gas Lgt Jour—Jan. 24, 1898. No. 17982.

Gas Sales.

Gas Sales in the United States, Canada, England and Germany. Extract from the presidential address of Charles H. Nettleton, at the meeting of the American Gas Lgt. Assn. 1000 w. Eng News—Jan. 20, 1898. No. 17945.

Gas Works.

An Examination of the Construction of the City Gas Works at Simmering (Besichtigung des Baues des Städtischen Gaswerkes in Simmering.) Showing photographic views of retort house, gas holders, &c, in course of construction for this important suburb of Vienna. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 24, 1897. No. 17811 B.

Heat Units.

The Balance Sheet of Heat Units in Coal Distillation. Herman Poole. An outline of what may be ascertained regarding the heat energy of coal and its products in gas-making. 3400 w. Am Gas Lgt Jour—Jan. 24, 1898. No. 17981.

Photometry.

The New Flicker Photometry. F. L. Tufts. Presented as a graduation thesis to the faculty of Columbia University. Outlines the general method of comparing luminosities, giving history of work of various investigators. Also describes apparatus used in the study of flicker phenomena. 3400 w. Pro Age—Jan. 15, 1898. Serial. 1st part. No. 17732.

The Weber Photometer and the Measurement of Daylight. Describes an apparatus for measuring the intensity of light given off by illuminated surfaces, also to measure the intensity of the light source. Ill. 1000 w. Gas Wld—Jan. 8, 1898. No. 17925 A.

Poisoning.

Gas Poisoning. W. B. M'Vey and J. E. Grinfield-Coxwell. Read before the Medico-Legal Society. Claims that the substitution of water-gas for coal-gas has greatly increased the danger of gas poisoning. Gives case with reports on condition at various intervals. Discussion. 2500 w. Pro Age—Jan 1, 1898. No. 17501.

Retrospect.

A Retrospect of the Year 1897. Deals principally with the gas industry in England. 4500 w. Jour of Gas Lgt—Dec. 28, 1897. No. 17615 A.

Review.

Review for the Year 1897. A lengthy review of the events of the gas industry in the United States during the year. 1600 w. Pro Age—Jan. 15, 1898. No. 17731.

Revivification.

The Heat of Revivification. Herman Poole. Discussion of the chemical action going on in the purifying material and its subsequent revivification. 2000 w. Am Gas Lgt Jour—Jan. 3, 1898. No. 17553.

Standard.

Report on the Dibdin Standard of Light. First report of a committee appointed by the Institution of Gas Engineers (England) to examine and report concerning the accuracy of the Dibdin 10-candle pentane standard. Also Mr. Dibdin's opinion. 3000 w. Gas Wld—Jan. 15, 1898. No. 18003 A.

Welsbach.

Indirect or Diffused Illumination of Class Rooms and Workshops by Welsbach Incandescent Lamps. F. Kermander and W. Prausnitz, in the *Journal des Usines a Gaz.* Translated by Herman Poole. Presents the advantages of indirect illumination, and gives results of experiments made. 900 w. Am Gas Lgt Jour—Jan. 17, 1898. No. 17774.

The Indirect Lighting of Schools by Welsbachs. F. Kermaner and W. Prausnitz. Abstract. States the fault of direct systems, the merits of indirect lighting, with practical results. 2400 w. Gas Wld—Jan. 1, 1898. No. 17673 A.

SEWERAGE.

Germany.

The Sewerage of Hanau, Germany. James H. Fuertes. Illustrated details of design and construction. 800 w. Eng Rec—Jan. 8, 1898. Serial. 1st part. No. 17657.

Purification Plant.

Rapid Double Filtration and Aeration of Sewage at Reading, Pa. Illustrated description of purification plant where the sewage is first screened through coke, then filtered twice, being aerated by dropping from the first filter bed to the second. 5500 w. Eng News—Jan. 27, 1898. No. 18028.

Sanitation.

The Sanitation of Domestic Buildings. Frank Latham. Part first is introductory and shows the danger of neglecting defective house drains, citing cases of serious illness and death from this cause. 1500 w. San Rec—Jan. 7, 1898. Serial. 1st part. No. 17769 A.

Septic Tank.

The Septic Tank System of Sewage Treatment at Exeter, England. Albert S. Crane. Brief description of the plant and the method of operating. Also information from English engineering papers. 2400 w. Eng News—Jan. 13, 1898. No. 17712

Sewage.

Ammoniacal Nitrogen in Sewage and Effluents. W. J. Dibdin. A discussion of the analytical results of certain bacterial methods of treatment. Gives results of analyses obtained by the process known as the septic tank, and the Sutton system. 1200 w. San Rec—Jan. 7, 1898. No. 17768 A.

Sewer Pipe.

The Strength of Sewer Pipe and the Actual Earth Pressure in Trenches. Frank A. Barbour. Experiments are described which were undertaken to determine where and under what circumstances it is necessary to use other than standard pipe, and whether failures are due to poor pipe or poor construction. Tabulated results are given, also discussion. Ill. 17500 w. Jour Assn of Engng Socs—Dec., 1897. No. 17975 C.

STREETS AND PAVEMENTS.

Frozen Concrete.

Frozen Concrete Pavement Foundations. A pavement foundation in Des Moines, Ia., was frozen just after it was laid. Twelve months after a sample was examined and its condition is reported, with the reasons of city engineer L. Higgins for believing that the conditions may be such as not to destroy the value by freezing. 1000 w. Eng Rec—Jan. 1, 1898.. No. 17506.

Street Cleaning.

Street Cleaning in New York. Describes some of Col. Waring's methods of keeping the city clean. 3500 w. Eng Rec—Jan. 8, 1898. No. 17655.

Wood Blocks.

Wood Block Pavements in Atlanta. Describes the process invented by H. F. Willams, of San Francisco, that is to be used here, and also gives report on the way in which similar pavements in San Francisco are wearing. 1300 w. Eng Rec—Jan. 1, 1898. No. 17505.

WATER SUPPLY.

Cincinnati.

Water System of Cincinnati. Information from the 57th annual report of the water department. Ill. 1300 w. Fire & Water—Jan. 8, 1898. Serial. 1st part. No. 17638.

Cleaning a Reservoir at Cincinnati. Willis P. Thorp. Describes the cleaning process used in removing the sediment from the west basin of the Eden reservoir, giving some information of former methods used. Ill. 1400 w. Fire & Water—Jan. 15, 1898. No. 17759.

Filtration.

Sand Filtration at Mount Vernon, N. Y. John S. Chester. Remarks concerning the construction and operation of this filter. Ill. 1200 w. Fire & Water—Jan. 1, 1898. No. 17547.

Fire Protection.

Supplementary Water Mains for Fire Protection. Extracts from report of Foster Crowell. Describes the systems in use in Cleveland, Milwaukee, Detroit, Buffalo, and Boston. 3800 w. Eng Rec—Jan. 8, 1898. No. 17656.

Forestry.

The Relation of Forestation to Water-Supply. Herbert M. Wilson. An important paper by the geographer of the U. S. Geological Survey, showing that there is no proof that deforestation has any appreciable effect on rainfall, or upon the subsequent run-off. 4500 w. Engineering Magazine—February, 1898. No. 18081 B.

Geological Survey.

Investigations of Water Supply by the U. S. Geological Survey. F. H. Newell. Read at meeting of the American Public Health Assn. An explanation of the extensive work done, and an application of the data to the drainage basin of the Potomac. 2200 W. San—Jan., 1898. No. 17666 D.

Metropolitan System.

Opening of the Metropolitan System, New York. The new pipe line of this system was opened on New Year's Day. In an address given the scope of the work undertaken is set forth. 1700 w. Fire & Water—Jan. 8, 1898. No. 17639.

Peoria, Ill.

Supplemental Pumping Plant of the Peoria Water Co., Peoria, Ill. Dabney H. Maury, Jr. Describes the method adopted to secure an additional water supply. The system consists of Pelton wheel driving centrifugal pumps. The construction of the plant was attended with great difficulties. Ill. 2700 w. Eng News—Jan. 13, 1898. No. 17713.

Pipe Laying.

Laying Pipe Under Difficulties. Illustrated description of a difficult piece of work in Waterbury, Conn, caused by a break in the connection of iron and cement pipes where a brook crosses the street. 1000 w. Fire & Water—Jan. 8, 1898. No. 17640.

Records.

The Best Method of Handlng Applications and Permits of Water Companies. Describes and explains the use of the card index system for this purpose. 900 w. Munic Engng—Jan., 1898. No. 17532 C.

Review.

Water and Sanitary Affairs of 1897. Reviews the principal events of the year in England, relating to this subject. 3800 w. Jour of Gas Lgt—Dec. 28, 1897. No. 17616 A.

River Pollution.

The Pollution of the Potomac River. Statements from two papers read before the National Geographic Society, at Washington, one by A. A. Davis, describing the physical characteristics, drainage area, sources of pollution, etc., and the other by E. K. Sprague, dealing with the bacterial side of the subject. 1000 w. Eng News—Dec. 30, 1897. No. 17483.

Submerged Mains.

Laying Submerged Water Mains. Describes

the laying of a 16-inch pipe across the Cedar River, Iowa, and a 24-inch main at Nashua, N. H. 1000 w. Eng Rec—Jan. 1, 1898. No. 17504.

Laying a Submerged Water Main in Cleveland, O. Illustrates the manner in which a 48-inch main was laid across a narrow stream. 350 w. Eng Rec—Jan. 29, 1898. No. 18149.

Surface Waters.

On Odors and Tastes of Surface Waters, with Special Reference to Anabaena, a Microscopical Organism found in Certain Water Supplies of Massachusetts. D. D. Jackson, and J. W. Ellms. Investigations of organisms giving surface water a disagreeable odor or taste, with results of analysis, &c. 3500 w. Tech Quar—Dec., 1897. No. 17647 F.

Water Mains.

Testing Water Mains in Place at Detroit. Describes and illustrates a device for testing the pipe in short intermediate sections, irrespective of the position of the valves. 900 w. Eng Rec—Jan. 22, 1898. No. 17964.

Water Rates.

The San Diego Water-Rates Case. The text of an important decision by the Supreme Court of California. Part first give the opinion of Justice Van Fleet, Justices Henshaw and McFarland concurring. 3600 w. Eng Rec—Jan. 15, 1898. Serial. 1st part. No. 17764.

Water Storage.

Water Storage Tanks Under Air Pressure at Babylon and Southampton, N. Y. Brief description of this system of water storage. Ill. 1100 w. Eng News—Dec. 30, 1897. No. 17480.

Water Supply.

Water Supply. Editorial review of the lessons of the year, and the supply in various parts of England. 1700 w. Engr, Lond—Jan. 7, 1898. No. 17904 A.

Zurich.

The Water Supply of Zurich. (Die Wasserversorgung von Zurich.) Official report for the year 1896, giving data concerning the use of high pressure water for power, as well as city supply. Also describes bacterological and chemical researches. Capacity is 6,500,000 gallons per day. 2500 w. Gesundheits-Ingenieur—Dec. 31, 1897. No. 17846 B.

MISCELLANY.

Destructors.

Dust Destructors. George Watson. Read at meeting of Gloucestershire Eng. Soc. and reported in the *Gloucester Journal.* Abstract. Deals with the dust destructor from the earliest to tho latest developments, especially describing the Horsfall destructor furnace. Discussion. 6000 w. Elec Eng, Lond—Dec. 24, 1897. No. 17589 A.

The Bullerdeich Destructor Plant for the City of Hamburg. (Die Städtische Verbrennungsanstalt für Abfallstoffe am Bullerdeich zu Hamburg.) Describes the Horsfall and Whiley garbage destructor cells as used at Hamburg. The plant has a capacity of nearly 80,000 tons per year, and the destruction costs 0 84 mark per ton. 2500 w. Gesundheits-Ingenieur—Dec. 31, 1897. No. 17845 B.

Farm Buildings.

Sanitary Farm Buildings. Louis Hanks. The importance of farm sanitation, and suggestions of how to secure the essentials. 1600 w. San Rec—Jan. 14, 1898. No. 18012 A.

Fire Alarm.

See Electrical Engineering, Telegraphy and Telephony.

Fire Protection.

The Equipment and Organization of a City Fire Department. Hugh Bonner. A discussion of the organization of the fire department of New York City as typical of the general principles of municipal equipment, by the chief of the New York Fire Department. 4000 w. Engineering Magazine—February, 1898. No. 18080 B.

London Fire.

See Architecture and Building, Miscellany.

Municipalization.

The Juridic Side of the Municipalization of Tramways. George Beynon Harris. Part first deals with the means by which a corporation may become possessed of a tramways undertaking, according to English law. 1600 w. Elec Eng, Lond—Jan. 14, 1898. Serial. 1st part. No. 18010 A.

Municipal Work.

See Electrical Engineering, Miscellany.

New York.

New York's Civic Assets. William Howe Tolman. A summing up of the progress made during Mayor Strong's administration, giving explanation of the mistakes and praise for the patriotism and civic pride, which studied always the city's welfare, showing that the assets will far exceed the liabilities. 5000 w. Am Rev of Revs—Jan., 1898. No. 17570 C.

Public Works.

An Outline of Municipal Laws Governing Public Works. An outline by David Molitor, of what in his judgment, would be the best form of municipal government for conducting public works. 6000 w. Munic Engng—Jan., 1898. No. 17531 C.

Municipal Ownership and Municipal Control. Charles Carroll Brown. Brief discussion of what works are best owned by the city. 900 w. Munic Engng—Jan., 1898. No. 17530 C.

Refuse.

Is Dustbin Refuse a Fuel? Norton H. Humphreys. An examination of the fuel used in the Shoreditch district, and why it can be used for steam-raising purposes. Does not consider ordinary household refuse inflammable. 1700 w. Jour Gas Lgt—Jan. 25, 1898. No. 17704 A.

Sanitation.

Sanitary Engineering. Editorial review of the year's work in this field. 1500 w. Engr, Lond—Jan. 7, 1898. No. 17903 A.

RAILWAY AFFAIRS.

NEW CONSTRUCTION.

China.

Railway Building in China. J. T. M. A summary of the lines which may possibly be built in the empire in the near future. 2000 w. Ry Age—Dec. 31, 1897. No. 17539.

MAINTENANCE OF EQUIPMENT,

Axle Bearing.

The Busse Adjustable Axle Bearing for Locomotives. (Nachstellbares Achslager für Lokomotiven, Bauart Busse.) A three part axle box with improved wedge adjustment, especially intended for the journal bearings of main locomotive axles. 1200 w. Glaser's Annalen—Jan. 1, 1898. No. 17813 D.

Brakes.

Standardized Driver Brakes C. & N. W. Ry. Describes the new design made with adjustable links adopted on the Chicago & Northwestern Railway. Ill. 800 w. Am Eng & R R Jour—Jan., 1898. No. 17512 C.

Car Heating.

Combined High and Low Pressure Steam Heating System of the Prussian State Railways. (Vereinigte Hoch-und Niederdruck-Dampfheizung der Preussischen Staatsbahnen.) A system especially adapted for the compartment carriages used in Germany, and enabling the temperature to be regulated independently in each compartment. 1000 w. 1 plate. Glaser's Annalen—Dec. 15, 1897. No. 17812 D.

Economies.

Fads, Customs and Their Cost. R. P. C. Sanderson. A paper and discussion on the points where savings can be made in the maintenance of equipment, without impairing the efficiency. 20500 w. N Y R R Club—Dec. 16, 1897. No. 17762 D.

Electric Locomotive.

See Street and Electric Tramways.

Fish-Commission Car.

The Transportation by Rail of Fish and Fish Eggs. Illustrated description of the United States Fish Commission car, which is adapted for the distribution of live fishes. 1000 w. Sci Am—Jan. 8, 1898. No. 17556.

Gondola Car.

Gondola Car; Chicago & Eastern Illinois R. R. Illustrated description of a car of 80,000 pounds capacity. 900 w. R R Car Jour—Jan., 1898. No. 17670.

Intercepting Valves.

The Schenectady Locomotive Works.—Intercepting and Separate Exhaust Valves for Compound Locomotives. Sectional views with description of valve designed by A. J. Pitkin and J. E. Sague. The form illustrated is the standard construction for their compound locomotives. 1200 w. Loc Engng—Jan., 1898. No. 17588 C.

Locomotives.

A "Balanced" Locomotive? Novoye Vremya. Letter to the editor criticizing an American locomotive, and claiming the design to be inferior in almost every particular to other engines. Gives analysis of forces and expresses general disapproval. Ill. 2800 w. Engng—Dec. 31, 1897. No. 17692 A.

A Curious Tunnel Locomotive. Illustrated description of a locomotive designed to work in tunnel headings, having the limited dimensions of 8 ft. 6 in. in width and 7 ft. 6 in. in height above the level of the rails; also to work in the open. 2500 w. Engr, Lond—Dec. 31, 1897. No. 17695 A.

An English Four-Cylinder Compound Locomotive with a Two-Compartment Smoke Box. An engine of the four-cylinder compound type, designed by F. W. Webb, is illustrated and described. 700 w. Eng News—Jan. 6, 1898. No. 17574.

Building a Locomotive. An illustrated account of the building of this machine, mentioning the different branches of the work. 2000 w. Loc Engng—Jan., 1898. No. 17586 C.

Compound Locomotives. (Les Locomotives Compound.) E. Sauvage. A classified historical discussion of compound locomotives in Europe and America, with details of proportions and account of tests. Four articles, many illustrations. 30000 w. Revue de Mécanique—Jan., Mar., May, Aug., 1897. No. 17883, each H.

Cooke Locomotives for the Oregon Short-Line Railway. Illustrated description of improved consolidation locomotives recently built. 500 w. Ry & Engng Rev—Jan. 22, 1898. No. 18021.

Electric Locomotives at Potsdam. Illustrated description of a locomotive which has for two years been operated in the railway repair shops near Berlin, Germany. 400 w. Ry Wld—Jan., 1898. No. 17913 A.

Electric Locomotive on the Hoboken Shore Road. Describes and illustrates the new locomotive recently put into service for hauling trains of loaded and empty freight cars between the docks and the Erie track. 600 w. Elec Rev, N. Y.—Jan. 5, 1898. No. 17557.

Glasgow & South-Western Four-Cylinder Simple Engine. Engraving, half-sectional plan, principal dimensions, and other particulars. 400 w. R R Gaz—Jan. 14, 1898. No. 17747.

Heavy Twelve-Wheel Locomotives for the Great Northern. Illustrated detailed description with general dimensions. 1200 w. R R Gaz—Jan. 7, 1897. No. 17562.

Locomotives for the Chinese Imperial Railways. Illustrated description of the machines supplied by the Baldwin Locomotive Works of Philadelphia. 1000 w. Engng—Jan. 7, 1898. No. 17785 A.

Locomotives with Double Smoke Stack; Toledo, Peoria & Western Ry. Illustration of this device, with a statement of the advantages claimed. 400 w. Eng News—Jan. 27, 1898. No. 18032.

Locomotives with Double Valves and Ports. London & Southwestern Ry. Illustrated description with dimensions and drawings. 500 w. Eng News—Jan. 13, 1898. No. 17714.

New Locomotive Types of 1897. Illustrated description of new types introduced during the year on English railways. 2500 w. Ry Wld—Jan., 1898. No. 17914 A.

Powerful Simple Locomotives for the Great Northern Railway, U. S. A. Illustrations and a description of the interesting details of the design. This article is confined to the boiler and the cylinders. General dimensions are given. Built by the Brooks Locomotive Works. 1200 w. Am Eng & R R Jour—Jan., 1898. No. 17511 C.

The New Heilmann Electric Locomotive. L. Bayly, in *Ingenieur Electrique*, Paris. Detailed description of the latest type of this machine, with illustrations. 1300 w. Elec Eng, N. Y. —Jan. 20, 1898. No. 17936.

The Performance and Design of Locomotives. A. von Borries. Extracts from an important work, "Die Eisenbahn Technik der Gegenwart," selected and translated by W. W. Nichols. Part first is a study of the resistance to motion, and the performance of locomotives. 2000 w. R R Gaz—Jan. 14, 1898. Serial. 1st part. No. 17746.

Two Recent Baldwin Locomotives. Engravings, dimensions and other particulars. 300 w. R R Gaz—Dec. 31, 1897. No. 17486.

Repairs.

How to Make Heavy Repairs on the Locomotive Boiler. Henry J. Raps. Directions and suggestions for quick and efficient work. Ill. 3000 w. Loc Engng—Jan., 1898. No. 17587 C.

Roller Bearings.

The Theory of Rolling Surfaces. (Théorie du Roulement des Surfaces.) R. Dubois. A geometrical study of the action of rolling surfaces with especial regard to the construction of roller bearings and ball bearings for railway axles. 8000 w. Revue de Mécanique—Sept., 1897. No. 17896 H.

See also Mechanical Engineering, Miscellany.

Royal Train.

The Hungarian Royal Train. (Der Ungarische Hofzug.) An illustrated description, with interior views of the various cars, of the private train for the use of the royal family on the Hungarian railways. 1500 w. 1 plate. Zeitschr d ver Deutscher Ing—Dec. 18, 1897. No. 17802 D.

Safety Appliance.

Extension of Safety Appliance Law. On the order for extending for two years the time within which the U. S. railroads must comply with this law, with digest of arguments. 1500 w. R R Car Jour—Jan., 1898. No. 17669.

Steel Cars.

Steel Freight Cars—M. C. B. Designs. Editorial discussion of the three designs for steel cars presented at the 1897 convention, also replying to questions asked by the committee in their circular of inquiry. 1700 w. Am Eng & R R Jour—Jan., 1898. No. 17514 C.

Vestibule.

A Home Made Vestibule—Great Northern Railway, U. S. A. Drawings and description of the standard design finally adopted. 800 w. Ry Mas Mach—Jan., 1898. No. 17618.

Wheel Tests.

Tests of Special Quality Chilled-Iron Car-Wheels at Buffalo, N. Y. Reports tests, under the auspices of the Central Railway Club made to demonstrate the comparative value of steel-tired wheels, and special quality chilled-iron wheels for high-grade serivce. 1300 w. Eng News—Jan. 27, 1898. No. 18034.

Wheels.

The Mileage of Chilled Cast-Iron Wheels in Freight and Passenger Service. Tables up to date, showing service. 500 w. Am Eng & R R Jour—Jan., 1898. No. 17513 C.

MAINTENANCE OF WAY.

Outside Rail.

Forces Acting on the Outside Rail. F. T. Hatch. A study of this subject with results. Ill. 1200 w. R R Gaz—Dec. 31, 1897. No. 17485.

Railway Bridges.

Notes on Light Railway Bridges. Illustrated description of a bridge built under rather difficult conditions,—the Gerüstpheiler Viaduct, designed and carried out by the government engineers of the Saxon States Railways. It is built of trestle piers or lattice-work columns, on a curve of 125 m. radius and with a gradient of 1 : 40. Calculations of strains and details of construction are given. 4000 w. Engr, Lond—Dec. 24, 1897. No. 17594 A.

Track Elevation.

Track Elevation in Chicago. Summary of what has already been published on this subject, with additional information of interest, taken from report made to the Department of Public Works, Chicago. 1700 w. R R Gaz—Jan 14, 1898. No. 17748.

Track Inspection.

Track Inspection on the Louisville and Nashville. Describes a car recently fitted for track inspection, and the method of work. 1500 w. Ry & Engng Rev—Jan. 8, 1898. No. 17671.

SIGNALING.

Automatic Signals.

Disadvantages Attending the Operation of Automatic Signals on the Normally Danger System. J. P. Coleman. Shows some causes of relay failures, and how much more seriously the failures affect the normally danger system than they do the normally clear system. 2700 w. Ry & Engng Rev—Jan. 8, 1898. No. 17672.

Interlocking.

Interlocking Plant at State Line Crossing Near Chicago, Ill. Illustrates and describes one of the largest interlocking plants in the United States. 1700 w. Eng News—Jan. 20, 1898. No. 17946.

Signal Engineer.

The Signal Engineer. W. H. Elliott. Read before the Railway Signaling Club. Discussion of this department of railway operation; the proper one to receive reports, and give orders, repairs, maintenance of inter-locking plant, etc., are considered. 1800 w. Ry & Engng Rev—Jan. 15, 1898. No. 17930.

Signal Work.

Foundations for Signal Work. Charles Hansel. Description with illustrations of approved design. 1100 w. R R Gaz—Jan. 7, 1898. No. 17564.

TERMINALS AND YARDS.

New York Station.

Refacing the Grand Central Station Walls. Brief description, with illustration, of the veneer of artificial stone being built over the reconstructed station, which is to give the effect of solid coursed ashlar fronts of gray stone. 800 w. Eng Rec—Jan. 15, 1898. No. 17765.

Station Enlargement.

The Enlargement of the Grand Central Station, New York, N. Y. Illustrated description of improvements being made, estimated to cost about $1,000,000. 2000 w. Eng News—Jan. 6, 1898. No. 17575.

Switzerland.

Plans for a Union Station for the Swiss Railways at St. Gall. (Das Umbau Projekt der Vereinigten Schweizerbahnen für den Bahnhof St. Gallen.) With plan showing the approaches and track connections, as well as the relation to the city, together with a profile of grades. 2500 w. Schweizerische Bauzeitung—Dec. 25, 1897. No. 17837 B.

TRANSPORTATION.

Accidents.

Do Railways Deserve Credit or Blame for the Number of Lives Lost in Their Operation? E. P. Ripley. Extract from a letter to the public dealing with the subject of railway accidents. 4500 w. Ry Age—Jan. 21, 1898. No. 17974.

Train Accidents in the United States in November. Detailed list with classified summary and comments. 4400 w. R R Gaz—Dec. 31, 1897. No. 17488.

Train Accidents in the United States in December. Detailed list and classified summary. 4500 w. R R Gaz—Jan. 28, 1898. No. 18060.

Earnings.

Satisfactory Railroad Earnings. The month of December shows very favorably. Tabulated reports of increases and decreases are given. 700 w. Bradstreet's—Jan. 15, 1898. No. 17743.

England.

"Long and Short Haul" in England. W. M. Acworth. States the facts to correct a misunderstanding of English practice, as given in the report of the Interstate Commerce Commission. 1000 w. R R Gaz—Jan. 21, 1898. No. 17955.

Interstate Commerce.

Demanding a Dangerous Privilege. Thomas P. Grasty. Claims that the ambition of the interstate commerce commission menaces the South and the country at large. 2000 w. Mfrs Rec—Jan. 14, 1898. No. 17733.

Pooling.

Pooling Locomotives and Locomotive Crews. J. F. Deems. Abstract of paper presented at meeting of the Western Railway Club. Explains the system of handling engine crews known as "pooling," with evidence of its worth, based on testimony of those who have tried it. 2800 w. Ry & Engng Rev—Jan. 22, 1898. No. 18022.

Should Congress Legislate on the Subject of Railway Rates? Aldace F. Walker. Extracts from a synopsis of a paper. Also editorial. Considers the constitutional right, the practical common sense, the demand for additional power in this direction, etc. 7000 w. R R Gaz—Jan. 7, 1898. No. 17563.

Rates.

Railroad Rates in Kansas. Abstracts of some portions of an open letter by E. P. Ripley, of the Atchison, Topeka & Santa Fe Ry., bearing upon railway rates and methods used by anti-railroad agitators. 5500 w. Ry & Engng Rev—Jan. 15, 1898. No. 17931.

The New Russian Grain Rates. Explains the new schedule of rates and comments on its importance to farmers and carriers of the United States. 1500 w. R R Gaz—Jan. 21, 1898. No. 17958.

Traffic Review of 1897. Editorial review of events affecting rates of traffic in various parts of the United States. 1700 w. R R Gaz—Jan. 14, 1898. No. 17750.

Speeds.

Railway Maximum Speeds. Charles Rous-Marten. Reports personal investigation of English locomotive speeds since 1894 and expresses disbelief in the records claimed for American locomotives. 2000 w. Engr, Lond—Dec. 31, 1897. No. 17696 A.

Ticket Brokerage.

The Anti-Scalping Bill. Editorial report of the statements of George W. Boyd of the Pennsylvania Road, and Messrs Daniels, King and Dill. 1400 w. R R Gaz—Jan. 14, 1898. No. 17749.

MISCELLANY.

Acceleration.

Comparative Rates of Acceleration. George L. Fowler. Gives a diagram showing the comparative rates of acceleration of the Schenectady experiments and those obtained by the writer, with conclusions. 1100 w. R R Gaz—Jan. 21, 1898. No. 17956.

Engineering Work.

The Illinois Central Improvements at Chicago. Illustrated description of the work of track depression and rearrangement of terminal yards, bulkhead work, viaducts, &c. 4300 w. R R Gaz—Jan. 28, 1898. Serial. 1st part. No. 18059.

Finances.

Receiverships and Foreclosure Sales in 1897.

A remarkable decrease. No year since 1887 has shown so few roads or so small mileage confessing insolvency. 900 w. Ry Age—Dec. 31, 1897. No. 17538.

India.

Indian Railway Property. Review of the experiences of the year, which were greatly affected by the pestilence, famine and war in some districts. 1300 w. Engng—Dec. 24, 1897. No. 17610 A.

Land Slides.

Land-Slides on the Canadian Pacific Railway. Robert B. Stanton. Abstract of paper read at meeting of the Inst. of Civ. Engs., England. Describes these slides and discusses the causes. 1000 w. Engng—Jan. 7, 1898. No. 17787 A.

Public Attitude.

The Public Attitude Toward Railways. From an address by J. T. Brooks of the Pennsylvania Railroad, at Purdue University. Considers watered stock; what justifies stock issues; uniformity of rates; competition and discrimination; causes of discrimination; and the public attitude towards pools. 5000 w. Ry Age—Jan. 14, 1898. No. 17771.

Railway Statistics.

The Official Statistics of the Railways of the United States in 1896. Abstracted matter from advance copy of the ninth annual report of the Interstate Commerce Commission's Statistician. 2000 w. Eng News—Dec. 30, 1897. No. 17482.

Report.

Abstract of Report: Board of Railroad Commissioners State of New York. Interesting abstracted matter relating to the condition of the roads, earnings, expenditures, improvements, equipment, &c. 3500 w. Ry & Engng Rev—Jan. 22, 1898. No. 18023.

New York Railroad Commissioners' Report. Review of this report which gives statistics for the year to June 30, 1897. 2000 w. R R Gaz—Jan. 21, 1898. No. 17954.

Reversing.

To Reverse or Not? M. E. On the different opinions held regarding the advisability of reversing the engine in time of danger. 1400 w R R Gaz—Dec. 31, 1897. No. 17484.

Station.

The Wettin Street Railway Station in Dresden. (Die Haltestelle Wettinerstrasse in Dresden.) Illustrated account of this fine new "through" railway station. The train shed has single braced arch roof 152 ft. span by 350 feet long. Two articles. 3500 w. Deutsche Bauzeitung—Dec. 18, 22, 1897. No. 17841 E.

Trolley Rivalry.

Connecticut Steam Trolley Rivalry. Reviews the measure of success attained by the third-rail system, reports extension proposed, and discusses the subject generally. 1200 w. R R Gaz—Jan. 14, 1898. No. 17751.

STREET AND ELECTRIC TRAMWAYS.

Aix-la-Chapelle.

Electric Tramway in the Suburbs of Aix la-Chapelle (Elektrische Kleinbahn in Landkreis Aachen.) Describes a system of over 30 miles of suburban electric road connecting Aix-la-Chapelle, Stolberg, Eschweiler, and Alsberg. Serial. Part I. 2500 w. Ill. Zeitschr f Klein u Strassenbahnen—Jan. 1, 1898. No. 17859 D.

Brooklyn Bridge.

The Use of the Brooklyn Bridge by the Transportation Systems of Brooklyn. An explanation of the first and the revised plans, and other complications. 1500 w. St Ry Jour—Jan., 1898. No. 17646 D.

Car Tracks.

Substructure of Street-Car Tracks, Buffalo, N. Y. Illustrates system of 60-ft. rails on longitudinal concrete beams. 300 w. Eng Rec—Jan. 8, 1898. No. 17658.

Changed Power.

Changing a Cable Conduit to an Electric Conduit. Illustrated description of the work in Washington, D. C., of replacing the cable with the underground electric system. 1300 w. St Ry Jour—Jan., 1898. No. 17645 D.

Conduit Roads.

Underground Conduit Electric Roads in America. Reviews the progress of electric conduit roads in the United States, giving brief accounts of a number of failures and of the successful roads. 1800 w. St Ry Rev—Jan. 15, 1898. No. 17775 C.

Dublin Tramways.

Electric Tramways in Dublin. Clontarf Section. Illustrated detailed description. 2000 w. Elec Rev, Lond—Dec. 24, 1897. No. 17597 A.

Efficiency.

The Efficiency of Tramway Motors. (Ueber den Wirkungsgrad von Strassenbahnmotoren.) E. G. Fischinger. The results of a number of tests are given, with tables and curves; the action of the gearing is especially considered, also the lubricants. Oil is preferred to grease for this service. 1500 w. Elektrotech Zeitschr—Dec. 23, 1897. No. 17863 B.

Electric Locomotive.

The Heilmann Electric Locomotive (La Locomotive Electrique. Système J. J. Heilmann.) A detailed description, with illustrations of the completed machine as well as the engines and motors, and an account of the preliminary trials. 2500 w. 1 plate. La Revue Technique—Dec. 25, 1897. No. 17822 D.

Employes.

Discipline of Employes. An explanation of the system of the Metropolitan West Side Elevated Railroad Company, of Chicago, which is based on the percentage classification. 1500 w. St Ry Rev—Jan. 15, 1898. No. 17778 C.

Germany.

Statistics of the Electric Tramways in Germany. (Statistik der Elektrischen Bahnen in Deutschland.) An elaborate tabulated view of the electric roads of Germany, giving location, gauge, system, capacity and other details. 10000 w. Elektrotech Zeitschr—Jan. 6, 1898. No. 17869 B.

Haulage.

See Mining and Metallurgy, Mining.

Ireland.

Electric Railways in Dublin and Cork. Illustrated description of the Clontarf section, Dublin, which has recently been electrically equipped ; also an account of the electric railways of Cork. 2000 w. St Ry Jour—Jan., 1898. No. 17643 D.

Jungfrau.

The Jungfrau Railway. (Die Jungfraubahn.) F. Hennings. A general description of the plans for the electric-rack railway to the summit of the Jungfrau, with a statement as to the present condition of the work. 3000 w. Zeitschr d Ver deutscher Ing—Dec. 25, 1897. No. 17803 D.

Locomotive.

See Railroad Affairs, Maintenance of Equipment.

Management.

Municipal Tramway Management. A comparison of the corporation-worked tramways of Leeds, Eng., with a tramway in the hands of a private company, and a discussion of the service and means of benefitting it. 3300 w. Ry Wld—Jan , 1898. No. 17915 A.

Motors.

Some Applications of Alternating Motors. Albert Gould Davis. Considers the advantages and disadvantages of alternating motors, the question of speed regulation, and their use in long-distance electric railway work. Ill. 3500 w. Elec Wld—Jan. 1, 1898. No. 17525.

The Use of Polyphase Motors on Electric Railroads. Charles Proteus Steinmetz. Discusses the use for the operation of railroad cars, reviewing the three methods for controlling polyphase railway motors, and comparing the relative advantages of polyphase and continuous-current motors. 2000 w. Elec Wld—Jan. 1, 1898. No. 17522.

Rail Bonding.

Railway Bonding. Walter E. Harrington. An outline of tests with conclusions favoring the Edison-Brown Bond. 900 w. Jour Fr Inst—Jan., 1898. No. 17651 D.

The Evolution of the Rail Bond. Harold P. Brown. Traces the development of these bonds as shown by the patents issued, and by the records of practical work. Ill. 2500 w. Elec Wld—Jan. 1, 1898. Serial, 1st part. No. 17526.

Railway Raising.

Raising a Chicago Elevated Railway. William M. Christie. Illustrated account of the raising of the South Side Elevated Railway. 2000 w. Eng Rec—Jan. 22, 1898. No. 17962.

Repairs.

Cutting Down the Cost of Electrical Repairs of Railway Motors. M. R. McAdoo. Explains a system of simple electrical tests which will indicate electrical weaknesses. Ill. 1800 w. St Ry Jour—Jan., 1898. No. 17644 D.

Repair Shop of the Chicago City Railway. Illustrated description of shop, tools, &c. 3600 w. St Ry Rev—Jan. 15, 1898. No. 17777 C.

Storage Batteries.

Storage Batteries as Station Auxiliaries in Pittsburgh. An illustrated description of the storage battery plants adopted, and some of the results secured in economy. 1700 w. St Ry Jour—Jan., 1898. No. 17642 D.

Electric Storage Battery Cars on the Englewood and Chicago Electric Railway. An account of the railway which employs this system exclusively. Ill. 3300 w. Eng News—Jan. 6, 1898. No. 17571.

Street Railways.

Relations of Street Railways and Municipal Corporations. Everett W. Burdett. Portion of argument in closing the investigations by special committee in Massachusetts, giving the points of widest interest. 10000 w. St. Ry Rev—Jan. 15, 1898. No. 17776 C.

Traction.

Remarks Upon Long-Distance Distribution for Electric Traction. André Blondel. Describes a method which operates on the principle of feeding the cars by a series distribution of constant current without the necessity of operating any switches or commutators upon the line by the passage of the trains. 2500 w. Elec Wld—Jan. 1, 1898. No. 17523.

Some Difficulties of Heavy Electric Railroading. Louis Bell. Considers the possible limitations. Discusses economy of operation, repairs, labor, etc., danger of breakdown of the system from accident, voltage, &c. in part first. 3000 w. Elec Wld—Jan. 1, 1898. Serial. 1st part. No. 17524.

Tramway Construction.

Recent Electric Tramway Construction in England. Harold Lomas. Part first gives a summary of the more important rules applying to the overhead-trolley system, with a brief history of electric traction in England, Ill. 1800 w. Elec Wld—Jan. 29, 1898. Serial. 1st part. No. 18070.

The Possibilities and Limitations of Electric Traction. Frank J. Sprague. The concluding article emphasizes the value of the multiple unit system and asserts that motors or motor combinations can be built which will surpass in power, and in tractive and speed capacities, any locomotive which it is practicable to construct and operate. 2800 w. Engineering Magazine—February, 1898. No. 18076 B.

Tramway Power.

Tramway Power from Lighting Stations. What is a fair price to charge is considered. The conclusion reached is that in the neighborhood of coal fields, the charge for power should not exceed three half-pence per unit, and should many times be less. 2500 w. Ry Wld—Jan., 1898. No. 17916 A.

BOOKS OF THE MONTH

Engineering and Architectural Jurisprudence. A Presentation of the Law of Construction, for Engineers, Architects, Contractors, Builders, Public Officers, and Attorneys at Law. By John Cassan Wait. M. C. E, LL. B. New York: John Wiley and Sons. London: Chapman and Hall, Limited. 1898.

The relations of engineering and architecture to jurisprudence are such as to make the practice of this branch of law a difficult and unsatisfactory one to both parties unless some especial training is had.

Attorneys at law are very often unfamiliar with the peculiarities and difficulties accompanying construction work, and in the examination of experts they are frequently lacking in the technical knowledge or even the command of scientific terms to an extent which prevents them from making the most of the case.

The same is true even in a greater degree as regards the unfamiliarity of engineers with the rules of evidence and court procedure, and they often make suggestions which are shortsighted and impracticable.

It is for the aid and instruction of both engineer and lawyer that Mr. Wait has prepared this important and valuable work, and from the fact that he is at the same time a trained engineer and a specialist in the practice of this branch of law, he is especially competent to execute the task in a thoroughly acceptable manner.

The author especially disclaims any intention of assuming that a few weeks or months study of text books can fit the engineer to practice or give advice in this branch of law, but a knowledge such as can be attained in this manner will often assist him in avoiding trouble and litigation, and aid him in protecting his employer's and his own rights when they are assailed.

To quote from the author's preface:

"It is hoped that the book will fulfill another mission—that of guiding and strengthening the younger and inexperienced members of the industrial professions in a proper understanding and appreciation of business and business relations. Young men in the engineering and architectural professions often obtain in their technical school training a contracted view of their professional duties and labors. They are likely to narrow their professional work to the ministerial duties of the drafting room, the shop or the field. Too many well trained and educated men remain in the shop or drafting room, while less skillful men from the accounting room and office, but with a good business experience become superintendents, managers, and presidents of the concerns employing them; and it should be said that frequently the latter, are more justly entitled to the place. The education of the engineer should fit him for a higher sphere than that of a delineator of lines. Supplemented with a good business experence, his training eminently fits him for the direction and superintendence of large works; and that is his proper field."

The work contains a large number of contract stipulations selected from a collection of many thousand, and many forms and precedents for almost every imaginable variety of work are given. As a work of reference the book is a valuable addition to the library of both lawyer and engineer, while to all who may be engaged in contract or construction work it will certainly be found most useful.

A Field Manual for Railroad Engineers. By J. C. Nagle, M. A., M. C. E. New York: John Wiley and Sons. London: Chapman and Hall, Limited. 1897.

Professor Nagle has prepared a very handy little field book for the railroad engineer, closely limited to the actual needs in the field, and yet so arranged that it may be used as a text book in the classroom. After chapters on "Reconnoissance," "Preliminary Surveys," and "Location," the subject of "Transition Curves" is taken up, the rigid method of Prof. Crandall being adopted, and simpler approximate methods being also given, with their limitations indicated. The subject of "Frogs and Switches" is also discussed at length, and a chapter on "Construction" closes the work. An appendix of tables is given, among which may be noted the table of functions of a one-degree curve, from which the functions for other curves may be taken under the assumption that they vary inversely as their degree or directly as their radii. The error from this assumption will, in any practical case, amount to no more than a few tenths or hundredths of a foot. The book will doubtless be found a handy field companion for the locating engineer, especially if he has used it in the class-room.

AMERICAN RAILWAY MANAGEMENT. Addresses Delivered before the American Railway Association, and Miscellaneous Addresses and Papers. By Henry S. Haines. New York: John Wiley and Sons. London: Chapman and Hall, Limited, 1897.

This volume contains a collection of addresses by the former vice-president and general manager of the Plant system of railway and steamship lines, upon such subjects as train rules, safety appliances, cost of transportation, labor organizations, operating expenses, freight rate classification, and many other matters of especial importance to railroad men and of general interest to the public at large.

Delivered, as most of these addresses were, to an assemblage of railroad men it is to be expected that such subjects as safety appliances, car couplers, labour organizations, and the like would be treated from the point of view of the railroad management; but in all cases there is manifested a disposition of fairness and correct insight which makes them interesting reading to all. Many of the papers contain statistics and data relative to railroading in America which are discussed in a manner enabling the general management of American railways to be grasped and understood by laymen of all countries, and in view of the present international interest in the relative cost of merchandise transportation in different countries the book is timely and valuable.

BOOKS RECEIVED.

The Planning and Construction of High Office Buildings. By William H. Birkmire. New York: John Wiley & Sons. London: Chapman & Hall, Limited.

The Proceedings of the Chemical and Metallurgical Society of South Africa. May, 1894—January, 1897. Vol. I. Edinburgh: R. W. Hunter. Johannesburg, S. A. R. The Chemical and Metallurgical Society of S. Africa.

High Masonry Dams. By E. Sherman Gould. Van Nostrand's Science Series, No. 22. New York: D. Van Nostrand Co.

Whittaker's Mechanical Engineer's Pocket Book. By Philip R. Bjorling. London: Whittaker & Co. New York: The Macmillan Company.

The Automotor and Horseless Vehicle Pocket Book of Automotive Formulæ and Commercial Intelligence for 1898. London: F. King & Co.

Placer Mining. A Handbook for Klondike and other Miners and Prospectors Scranton: The Colliery Engineer Company.

Introductory Course in Mechanical Drawing. By J. C. Tracy, M. E. With chapter on perspective by E. H. Lockwood, M. E. New York and London: Harper & Brothers.

American Gazetteer of Power Plants in the Principal Cities and Towns of Pennsylvania for the year 1897. Cleveland: Compiled and Published by the American Gazetteer Co.

Hendricks' Architects', Builders', Contractors' and Manufacturers' Directory of America. New York: Samuel E. Hendricks Co.

Preliminary Survey and Estimates. By Theodore Graham Gribble. Second Edition. London, New York, and Bombay: Longmans, Green and Co.

The Gas World Year Book, 1898. Edited by John Douglas. London: John Allan & Co.

Machine Design. Part I. Kinematics of Machinery. By Forrest R. Jones. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Eighteenth Annual Report of the United States Geological Survey. Charles D Walcot, Director. Part V. Mineral Resources of the United States, 1896. Metallic Products and Coal. Washington: Government Printing Office. 1897.

Commercial Directory of the American Republics. Compiled by the Bureau of American Republics. Joseph P. Smith, Director. Washington: Government Printing Office. 1897.

The Power Catechism. By F. R. Low. New York: The Power Publishing Co. 1897.

Mechanical Draft. A Practical Treatise. B. F. Sturtevant Co. Boston, Mass.

The Purpose of Textile Education. An Address at the Lowell Textile School. By C. J. H. Woodbury. Waltham, Mass.: Ephraim L. Barry. 1897.

Proceedings of the Fifth Annual Convention of the Traveling Engineers' Association. W. O. Thompson, Secretary. Elkhart, Indiana: Review Printing Co. 1897.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them.
Please mention The Engineering Magazine when you write.

The Ingersoll-Sergeant Rock Drill Company, New York.=Condensed edition of catalogue of Air-Compressors, containing illustrations of various types of compressors, with addresses of some of the users of these well-known machines. A very convenient little book for reference, and furnished on application to the company.

Henry Maurer & Son, 420 E. 23d St., New York=Illustrated catalogue of fire-proof building material for 1898. Several novel features in the line are shown which will interest engineers as well as architects. Their new Eureka arch, for light floor construction, is fully described and illustrated, and is strongly commended for fire-proofing where lightness of construction is desirable.

The Michigan Pipe Co., Bay City, Michigan, U. S. A. Manufacturers of Creosoted Wood Conduits for underground wires. = Illustrated pamphlet descriptive of the Bethell process of preserving timber by the use of creosote oil. Useful information is given about processes for preserving wood for various purposes, making the catalogue suitable for filing and reference.

Earle C. Bacon, Havemeyer Building, New York. Hoisting Engines, Mining Machinery, etc.=A description with many illustrations, of Bacon's hoisting engines, cableways, and winding engines, together with a general list of boilers, engines, pumps, pulleys and miscellaneous machinery, the whole forming a useful reference catalogue.

E. C. Atkins & Co. (Incorporated), Indianapolis, Ind. U. S. A.=A very complete and fully illustrated catalogue of saws and saw mill specialties, including circular and band saws, as well as cross-cut and hand saws, mandrels, dogs, and sharpening devices.

The J. M. Carpenter Tap & Die Co., Pawtucket, R. I., U. S. A.=Catalogue No. 12, of taps, dies, and threading tools of all kinds. About 5,000 sizes and kinds of screw-cutting tools are listed in this book in an admirable manner, in clear type, with blank line between each line of type.

The Q & C Company, Chicago, Ill., U. S. A. =Catalogue C and D, car door equipment and general railway specialties; catalogue E, the Q & C Scott Boiler Feeder. The latter contains useful information in connection with the question of steam consumption for boiler-feeding purposes.

Kutztown Foundry and Machine Co. (Incorporated).=Catalogue of the Rose Patent Grate, with directions for use, and extensive list of users.

The Railroad Supply Company, Chicago, Ill., U. S. A.=Defects of M. C. B. Couplers, and Their Cures. A few notes on the weak points of the present M. C. B. Couplers as commonly used, with illustrated description of the Hien Double Automatic Coupler and the manner in which it is intended to overcome such defects.

Easton & Bessemer, Ltd., Taunton, England. =Small illustrated price-list of engines, boilers, woodworking and grinding machinery, hydraulic pumps, and presses, with dimensions, weights, and prices of all machines illustrated.

Gandy Belt Mfg. Co., Ltd., 97 Queen Victoria St., London.=(*a*) Small paper-covered price list of belting and belting accessories, with maximum and minimum sizes of leather, cotton, hair, link, rawhide, and other varieties of belting; also particulars of rubber suction hose, valves, etc.; (*b*) price-list, in sheet form, of the "Dodge" wood split pulleys with instructions for telegraphic ordering.

The Reliance Lubricating Oil Co., 19 Water Lane, Great Tower Street, London.=Price-list of non-corrosive lubricants, with some remarks as to particular uses of the several kinds; also description of the Boverton Redwood, and the Coleman archbutt viscometers.

Arthur Koppel, 78–80 Broad St., New York.= A full list of materials for narrow-gage railway construction and operation, manufactured at Bochum, Camen, and Wolgart, in Prussia, and especially adapted for portable and mining railways, or for contractor's or plantation work. The catalogue is printed in English and Spanish, is very fully illustrated, and contains a special telegraph code for both languages.

Queen & Boulding, 21 Featherstone St., London.=Catalogue of the Buffalo injector, the Buffalo steam-jet pump adapted for raising water from deep wells, and of the "Tripp" metallic packing. The catalogue is fully illustrated and well printed, and gives usual information as to dimensions and prices. Some information regarding the Shipman petroleum engine and miscellaneous fittings, such as valves and flue-cleaners, is included.

Bever & Dorling, Dewsbury Foundry, Dewsbury, England.= *a*) List of friction clutches and couplings, with full description prices, and illustrations; (*b*) price-list of friction clutches, dealing with their application to wire rope haulage, of wrought iron pulleys, and of Gill's patent haulage clip; (*c*) price list of duplex pumps, with details of special advantages claimed, full dimensions, and prices.

The Vulcan Iron Works Co., Toledo, Ohio, U. S. A.=Catalogue of "Giant" and "Little Giant" Excavators, with excellent elevations and plans of various excavators and steam shovels, and specifications of details.

Boston Belting Co., Boston, Mass., U. S. A. =Catalogue of cotton and rubber garden hose, couplings, nozzles, sprinklers, reels, &c., with prices.

Hill & Smith, Brierley Hill Iron Works, Dudley, England.=Illustrated price-lists; (*a*) garden rollers, lawn mowers, and other horticultural requisites; (*b*) corn bins, galvanized-iron tanks, cisterns, and agricultural feeding appliances; (*c*) iron sheds and roofing for agricultural purposes; (*d*) abridged catalogue of patent continuous iron fencing; (*e*) leaflet illustrating ornamental wrought-iron band stands; (*f*) approximate price list of forgings up to 15 tons in weight; (*g*) price-list of housing pens and boxes for rolling mills; (*h*) beautiful photo book of hammered copper and iron ornamental art work. In all these price-lists concise information is given.

Clayton & Co., Atlas Works, Harrow Road, London.=(*a*) Comprehensive 40-page illustrated catalogue of brick, tile, and pipe machinery, with some statements of the operation, approximate weights, and capacities of the machines; (*b*) eight-page price-list, including prices of steam engines and boilers.

Herbert W. Periam, Floodgate Street Works, Birmingham, England.=Illustrated price-list of screws, rivets, and washers for engineers' use.

Fraser & Chalmers, Chicago, Ill., U. S. A. =Circulars, No. 25, 26, and 31, describing respectively the "Comet" adjustable gyratory crusher; the "New" Blanton self-tightening cam; and the "Otto" aerial tramway.

Stow Manufacturing Co., Binghamton, New York, U. S. A.=Illustrated catalogue of flexible shaft, with description and prices of many special tools for use in drilling, tapping, reaming, grinding, polishing, &c.

General Electric Co., Schenectady, New York, U. S. A.=Edison Incandescent Lamp catalogue, special reprint pamphlet of information for users of incandescent lamps.

John Wild & Co., Ltd., Falcon Ironworks, Oldham, England.=Ten-page fully-illustrated catalogue of colliery-engine plant, including portable and fixed hauling and winding engines, steam and electrical pumps, boilers, and steam engines. Horse powers, dimensions, and prices are briefly, but clearly, stated.

Richard Schram & Co., Cannon Street House, London.=(*a*) Neatly-printed illustrated catalogue of air compressing and rock-boring machinery, giving full description and results of lists of air compressors. Special attention is given to the new "Optimus" compound rock drill and to the "Root" water-tube boilers; (*b*) leaflet of hand-power diamond prospecting machine.

H. I. H. King & Co., Nailsworth, England.= "Engine" catalogue dealing with the King patent vertical compound, Corliss, compound non-condensing, compound Corliss, and tri compound Corliss engines; cylinder diameters and other dimensions are given, but not prices. Information on the Worthington self-cooling condenser and the King air pump is included.

Edison & Swan United Electric Light Company, Ltd. London =Handsome illustrated catalogue (section 6) of the "Ediswan" electric-light fittings, with prices.

Bowes, Scott & Western, Broadway Chambers, Westminster, London =Cloth-covered comprehensive catalogue of mining machinery, with very complete index. Practically all types of machinery in general use for metalliferous mining and smelting are included. Very fully illustrated, with concise descriptive matter.

Conrad Knap & Co., Ltd., London.=Cloth-covered catalogue of water-tube boilers, heaters, and Root's patent acme blowers; full descriptions and sectional drawings are given. Injectors and general steam fittings are also described.

Drake & Gorham, 66 Victoria St., London.= (*a*) Handsome cloth covered catalogue of electric lighting plants and accessories, including accumulators, switches, and incandescent lamps; (*b*) list of electric-light installations erected by this firm, giving class of motive power employed and the number of lights used; (*c*) excellently-printed catalogue of the "Jandus" arc lamp, with a large number of half-tone illustrations taken from actual plants; also instructions for mounting and trimming the lamp.

The Litholine Co., 32 Victoria St., Manchester, England.=Pamphlet relating to the use of litholine in preventing boiler corrosion and incrustation, with copies of testimonials from users.

Charles Thompson, Grantham, England.= Small pamphlet describing the Thompson "Universal" conveyor used for grain, barley, etc.

Beauland Perkin & Co., Leeds, England.= Pamphlet entitled "Some Observations on Enclosed Globe Arc Lamps," with special reference to the "Ajax" lamp sold by this firm; a price-list of the lamps is appended.

E. Green & Son, Ltd., 2 Exchange St., Manchester, England.=Very handsome paper-covered catalogue describing in great detail the Green fuel economiser, with illustrations of all parts and folding plates showing sectional drawings and affording hints in the design of steam plants; describes also the "Merithort" boiler and economiser feed pump. Tables and tests of the economy of the Green system are appended.

F. L. Hansell & Co., Eyre Lane, Sheffield, England.=Nine large sheets making a fully-illustrated list of steel castings, principally Sheffield steel wheels and axles, but also picks, shovels, hammers, blacksmiths' tools, steel barrows, gearing, and other similar lines.

Richard Garrett & Sons, Leeston, Suffolk, England.=40-page illustrated catalogue, devoted principally to portable steam engines and boilers, with several pages devoted to stationary engines, hauling engines for mining work, and the Turner-Hartnell patent governor.

Muntz's Metal Co. Ltd.=Handsome leather-bound pocket-book giving weights and thickness of copper tubes and a variety of valuable tables on seamless drawn copper tubes. Tables and information are given of sizes, weights of copper rods, brazed copper tubes, and bolts.

The Farnley Iron Co., Ltd., Leeds, England. =Large atlas giving diagram of rolled sections with sizes and weights in the English and metric systems; also information on boiler and flanged plates made of "Farnley" iron, the basis of which is the cold blast pig made by the firm.

C. Whittaker & Co., Accrington, England.= (*a*) Illustrated catalogue of clay-working and brick-making machinery, including grinding mills, mixers, presses, sieves, etc. The catalogue is well printed, and is in a cloth cover, weights, measurements, and capacities of the machines being given; (*b*) leaflet illustrating and describing the Whittaker semi-plastic brick-making machine.

For additional Catalogues, see page 30.

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